A First Book of Agriculture

FOR THE USE OF

SCHOOLS IN SOUTHERN INDIA.

PREPARED UNDER THE ORDER OF GOVERNMENT.

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CHAPTER I.

Agriculture and its Branches and the Preparation of Land for Cultivation.

The objects of agriculture.

THE food we eat, the clothing we wear, and many other things that are useful to man are derived from plants or from animals. For instance, rice, cotton and sugar are derived from plants; and milk, wool, silk and honey from animals. Animals live on plants, and thus it is that plants supply most of our wants, either directly or through animals. To make plants grow well, it is necessary to cultivate the land on which they grow; that is to stir and loosen it. Besides this, other things must be done with the same object. Now, the word "agriculture" means the cultivation of land, but includes also whatever must be done to produce the vegetable and the animal substances we desire to obtain from the land. Agriculture thus includes not only the proper cultivation of crops, but also the proper management of domestic animals. This is shown by the twofold division of agriculture into the branches "Field Husbandry" and "Pastoral Farming." The words "farming" and "husbandry" are frequently used as other names for "agriculture."

The branches of agriculture.

Field husbandry includes all that is necessary to promote the growth of crops, and, besides the ordinary cultivation of crops in the field, gardening or horticulture. Flowering plants, vegetables, fruit trees and other useful plants, which require close

attention, are cultivated in comparatively small plots of ground called gardens, which are usually surrounded by fences to protect them from trespass and damage. This branch is often very profitable, especially when the growth of vegetables is undertaken near large towns. Gardening is often also pursued simply for pleasure. Pastoral farming includes the care, management and breeding of farm stock—cattle, sheep and goats—and in some places a special branch, called dairy farming. This branch involves the maintenance of a large number of cows or she-buffaloes, so as to get as much milk as possible from them, and includes the growth of fodder for them, as well as the manufacture of butter, ghee, and various other articles from milk. Dairy farming is usually very profitable near large towns. In connection with dairy farming, it is well to keep poultry and sell eggs and fowls. The growth of trees or arboriculture, which includes the cultivation of topes and forests : the rearing of silk-worms or sericulture,—a business which is pursued in Collegal and Mysore, and includes the cultivation of the mulberry as a food for silk worms : the management of bees or apiculture, which includes the cultivation of such plants as produce flowers from which bees can obtain their honey : and lastly rearing fish or pisciculture, which is the art of increasing the number of good fish in tanks and other bodies of water and preserving them from wasteful destruction, are all branches of industry which may be usefully and profitably undertaken under proper conditions by the agriculturist or farmer, in connection with ordinary farming operations.

The farmer and his objects.

A man whose business is agriculture is called an agriculturist, farmer, or husbandman ; or more frequently

in this country, a ryot. The object of every ryot should be to obtain from the land the largest possible quantity of vegetable and animal produce at the least expense and with the least possible injury to the land.

The farm and its arrangement.

The area of land owned or occupied by one ryot, or farmer, is called a farm. It is always an advantage if all the land belonging to a ryot in a village lies together. The nearer the ryot's house is to his farm the better. It would be a very good thing, indeed, if the ryots of this country, like the farmers of England and some other countries, resided on their land themselves with their servants, and also had simple sheds thereon for their cattle and sheep. At present much of the time and labor of the ryot and his cattle is wasted in walking a long distance to and from his house in the village several times a day, and sometimes from one piece of land to another. The labor of carting manure from the village to the fields is also increased from the same cause. When he lives on his farm the ryot can watch his crops and do his other work better and protect his cattle and sheep from the risk of contracting disease, whilst for himself it is healthier. The ryot's house and sheds should be as nearly in the centre of his lands as possible, so that the carting of manure and field produce may be easy, and every part of the estate may be easily watched. There should be at least one well on his farm to provide good drinking water for his family, cattle, and sheep, and to water any garden he owns. Some fruit and fuel trees may well be planted near the house and sheds, and it would also be well to have a small belt of trees all round the estate, so as to protect the crops and animals from high winds.

Fences and their uses.

In this country good hedges around landed estates are rare, especially so in the districts of Bellary, Cuddapah, Kurnool, and Anantapur. Hedges are useful for preventing trespass of cattle and men, and for protecting crops and animals from high winds. The undermentioned plants make good hedges :—

The American aloe may be seen in the hedges on both sides of the railways. Young aloe plants must be planted in two or three rows on the top of an earthen bank about 3 ft. high all around the estate. The bank may be raised by digging a drain outside, and one also inside, leaving space enough between the bank and the inner drain for planting a hedge of corukaipuli or other plant. Fibre is obtained from the blades of the plant.

The plant called in Madras corukaipuli is a very useful fuel plant, which makes a good fence. It may be planted inside the aloe fence as said above. It may also be planted alone for dividing the estate into convenient blocks, if it be large. Where a hedge is wanted, dig a trench about 1½ ft. deep and one foot wide, put back the soil in the trench, manure it well, and sow good seed in two or three lines in wet weather. If watered in dry weather and taken care of for about three years, it will not require much attention afterwards. The hedge may then be cut once a year after the monsoon rains are over. A mile length of the fence will give yearly about 30 or 40 cart-loads of fuel. By growing such fences around his farm the ryot may provide himself with all the fuel he requires.

The plant called in Tamil 'seekay' and in Telugu 'seega kaya' is used as a hedge plant in some parts of Mysore. It may be planted like corukaipuli on good soil. Its fruit is very valuable, being used by

all the Hindus for washing oil off the body. The hedge supplies fuel also, being cut after the fruit is gathered.

The preparation of land for cultivation.

When land is newly taken up for cultivation, it needs in some cases a certain amount of preparation to fit it for tillage. In some places are found high mountains or hills, the sides of which are too steep to admit of cultivation; some land is covered by dense forests and jungles, and some is occupied by tanks, towns, villages, roads, rivers, &c. All the land cannot, therefore, be cultivated, as the portions forming the sides of mountains and hills and that occupied by towns and villages, river-beds, tanks, roads, &c., will always remain uncultivated. But a large portion of the land that is covered by forests and jungles may be tilled, after the removal of the trees and bushes.

The value of trees.

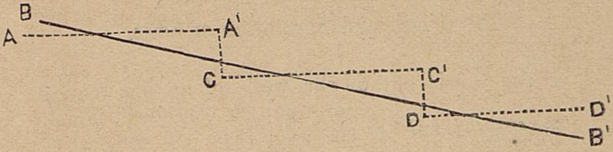
It must always be remembered, however, before beginning to cut down trees, that a tree may be cut down in a few hours that has taken many years to grow, probably more years than the oldest person in the village has lived. Therefore the matter must always be well considered before a tree is cut down. Great injury has been done to the country from trees having been recklessly cut down, and the land on which they grew left bare and uncultivated. Trees serve many useful purposes. They afford shade from the sun, and protection in stormy weather to men, beasts and birds. They protect the soil from loss of moisture in the hot season. They help to keep the air cool and moist. They furnish valuable fruit for food and other uses; and, when fit for no other purpose, may be cut down for timber

for building houses, making carts, ploughs, &c., or may be used as fuel for cooking food, for burning in brick-kilns and lime-kilns, and for other purposes.

As land densely covered by trees cannot be cultivated, it is necessary to cut down the trees and bushes on it before the land can be cultivated; but care must be taken to remove only those that interfere with the cultivation of the land. Trees in fields in which crops are grown injure the crops, and make the cultivation of the land more costly; they should therefore be removed; but if the trees in the field must be cut down, other useful trees should be planted on the portions of the land that cannot be ploughed. There is always some such land at the edge of water channels, at the sides of roads, near houses, and in other places. Trees need but little care, except that they must be protected from cattle, sheep and goats, and be watered in the dry season while young, but if they are manured they will grow much more quickly and need less water. Trees are not objectionable on pasture land, as they are useful in affording shade to cattle and sheep during the heat of the day. When the country is made bare by felling the trees and the clearance of jungle, the climate becomes more changeable; drought and flood, or the extremes, are more common; rain falls in extremely heavy showers and runs away rapidly, and the gentle showers desired by the farmer are no longer common.

Terracing.

Land which slopes very much, as some hill-sides, should be levelled, so as to form beds or terraces one above another, as shown in the annexed sketch, the terraces being shown by the dotted lines AA′, CC′, DD′, and the original slope by the line BB′.



Other improvements.

Again land is often found on which there are many large stones, and the working of the plough in the soil is thereby rendered difficult. The ryot may easily gather off these stones by degrees, and make a stone fence round his land by piling them there. Inferior land on the banks of streams may often be improved by ryots as follows. They put a dam of earth, sticks, and turf across the stream, so that, when it is in flood, the water overflows the banks. The water then loses its rapid current, and the muddy matter or silt which it contains settles on the land. The silting of land in this manner is called 'warping,' and where it can be thoroughly carried out, often makes the most fertile fields.

CHAPTER II.

The Origin and Formation of Soils.

The component parts of rocks and soils.

If the words cut on the walls of an old temple or tomb be examined, it will be seen that it is difficult to read the letters, as parts of them have worn away. This shows that even very hard stone wears away in time. If next a piece of such stone as is used in building the temple walls be taken and broken to a powder of the kind that is kept in many Hindu houses for drawing ornamental lines on floors after washing them with cow-dung, and if this powder be placed in a vessel with plenty of water and shaken, the water will become dirty or muddy. Then if the muddy water alone be poured off and clear water be again and again added, and the muddy water poured off continually until clear water if added does not become dirty, some hard and gritty powder will be left in the vessel. It is sand. On the ground where the muddy water has been poured some mud may be collected; it is sticky and soft. It is clay. Thus rock may be reduced to sand and clay. Most kinds of rock may be so reduced. A few, however, only yield sand when powdered, for instance, the rock powder used by the carpenter for whetting his chisels. A few rocks can be reduced to clay only. Plants, however, do not generally grow on hard rocks, but in a comparatively soft and loose layer which covers the land, called earth or soil. If a small quantity of any soil be taken and washed in the same manner as the rock powder, it will be found that it also, like most rocks, may be separated into sand and clay. Thus

soil and rock powder are very similar. But the soil is darker in color than the rock powder; and, if a little be placed in a vessel and heated red hot over a fire, when it cools again, it will be found less weighty and generally of a lighter color. This shows that some portion of the soil can be burnt. This portion that can be burnt is made up of the rotted remains of numbers of plants, as well as those of small animals like worms, insects, &c., which have lived and died in it. The name *organic matter* is given to this substance. A soil is thus made up of rock powder and organic matter.

The formation of soil from rocks.

The rock powder of which soils are composed is formed in the following ways amongst others:—

(1) If a rock be made very hot, as by fire for instance, and very cold water suddenly poured on it, it cracks in many places. Very hot sun is often succeeded by cold rain, and hot days by cold nights. The effect of such sudden and frequent changes is to split up rocks into many pieces, and in course of time into powder.

(2) Water soaking into a rock or stone makes it softer and more easily affected by other changes.

(3) A piece of iron left in the open air becomes brown at the surface in a few days and in time flakes begin to peel off it. The brown soft powder or flakes is called rust. Many rocks are brown at the surface, the iron on them having been rusted. When the rusted part is washed off by rain, another part of the rock is exposed to the air and becomes covered with rust also. This goes on continually, and gradually the rock becomes very soft and lastly falls into powder.

(4) In the beds of many rivers, the rocks are smooth and rounded and have numerous small furrows and troughs on their surface—clearly the rocks have been cut and smoothened gradually by the flowing water. This water carries down with it from the higher parts of the country broken pieces of rock and rock powder, separating at the same time the sand and the clay that it carries. The sand and the stones when pushed along the river bed grind the stones which form it into the furrows and troughs and form more rock powder in doing so.

(5) The Tamil poetess Auvaiyar says in her poem Nalvali, "Rocks which cannot be split by an iron crow-bar are split by the roots of trees." This can often be seen where a tree has taken root on a strongly built wall, which it gradually splits into many pieces, as its roots force their way through it and increase in size gradually till they separate the stones from each other, though they be built in the hardest chunam. So when the hardest rocks have been a little softened, very small plants which cannot be clearly seen by the naked eye begin to grow on them. The surface of the rocks is split up to some extent by the roots of these plants, and so after a time bigger plants can grow there, and after splitting the rocks up still more die, when still bigger plants can take their place, and so on till at length the worn-out rock, mixed with the remains of numberless plants which have grown upon it and died, becomes a soil fit for the growth of common crops.

Thus soils are formed by the breaking up of rocks by these means:—

(1) Sudden changes from heat to cold and from cold to heat.

(2) Soaking water.

(3) The effect of the air in rusting iron.

(4) The rubbing of rock powder carried by flowing water on their surface.

(5) Their being split up by the roots of plants.

When a river is in flood, the water, carrying with it the sand and clay, overflows the banks, and leaves the sand and clay there, as the current decreases; first, the sand, and then, the clay, is left behind. The banks of a river will generally be slippery, after the flood water has run off. This is owing to the layer of clay left by the water on the surface. If the clay is removed at any spot a layer of sand is usually seen below it. In fact the flood water has left sand and clay in layers. The sand being heavier than clay forms the bottom layer. A soil consisting of layers of sand and clay derived from a current of water is called an *alluvial soil*; sometimes when the rivers spread far they carry little but clay with them in their floods, but deposit this as a layer of silt, which often forms the most fertile soils.

CHAPTER III.

The Classification and Characters of Soils.

Soils classified according to their place of origin.

As soils are formed from rocks, it follows that their nature will depend on the rock from which they are formed. When a soil is found in the place where it has been formed, lying on the rock below, it is called a *Sedentary* soil. This class of soils is generally only a very thin layer covering the parent rock, and on them plants do not generally flourish, as their roots cannot penetrate deeply on account of the rock lying so near the surface. Soils of this class are to be seen covering the higher portions of many parts of the Ceded districts, Salem and Coimbatore and elsewhere, where remains of the original rock are to be seen all over the fields. Soils of another group are called *Transported*, that is, they have been derived from the breaking up of rocks lying at a distance from where they are found. These soils are of very varied character, from the sandy waste of the sea beach, to the deep, rich alluvium of the deltas of our great rivers. The transporting agent is most commonly running water, but in a few cases the wind also helps. An alluvial soil is an instance of a soil transported by water acting after the manner already described. Many such soils are of surpassing richness owing to the mingling of worn down particles of many different sorts of rocks. Soils transported by the winds are usually sandy and may be seen along the banks of some of our larger rivers, where the wind has blown the sand from the river bed over the banks.

Character of soils caused by composition.

According to the amount of sand and clay and organic matter in a soil, its character will vary ; but there is also one other substance sometimes present in soils which causes further differences ; that is, lime, which, when present in large quantities, greatly changes the natural characters of clay and sand. The method of separating from each other the organic matter, the clay and the sand in a soil, has already been explained. The presence of lime in large quantities will be shown when the soil froths when strong vinegar is poured on it.

Classification of soils by their composition.

When the clay and sand and organic matter have been separated, it is easy to divide soils into classes, and the names given to soils so classified are as follow :—

Clay soils.

A heavy-clay soil—that which contains more than $\frac{2}{3}$rds clay.

A clay-loam—that containing from $\frac{1}{2}$ to $\frac{2}{3}$rds clay.

Loamy soils.

A loam—that which contains about one-half clay and one-half sand.

A sandy-loam—containing about $\frac{2}{3}$rds sand.

Sandy soils.

A light sandy soil which contains above $\frac{3}{4}$ths sand.

Clay loams, loams, and *sandy loams* are often called loamy soils, and *sandy loams* and light sandy soils are often called sandy soils.

If organic matter exists in large quantities (more than a sixth part) in a soil, it would be called a peaty soil, but such soils only exist to a small extent on the Nilgiris, and a few other mountain ranges in S. India. The presence of a small amount of organic matter in a soil is much to be desired, and there

should be at least three or four parts in every 100 by weight of this substance in a soil.

If lime is found in large quantities, the soil would be called a lime or marly soil, and usually such soils are fertile, but if the amount present is excessive it is injurious.

All these soils may be of almost any color—black, red, or pale yellow, but their character and value do not depend much on the color. So the character of the different kinds of soil must be considered. Although the class to which a soil belongs may be determined by examining it as already shown, yet if the characters of each kind of soil as shown below are remembered, it is easy to tell one from another pretty accurately by the eye, and the touch of the hands or feet.

The characters of clay soils.

Perfectly pure clay is soft to the touch, sticky and plastic when wet, but powdery when dry, white like porcelain, which is in fact made of it, and quite useless for agriculture. The many colors of clay as it is seen in the fields are due to the substances found mixed with it; if it contains much organic matter, it will be dark colored; if much iron rust, it will be red. Clay weighs much less than sand; for whilst a Madras measure of clay weighs about 169 rupees' weight, one of sand weighs about 248 rupees. Nevertheless, a clay soil is called a *heavy soil*, simply because much force is wanted to draw tillage implements through it. In dry weather clay soils become hard and full of cracks, but in wet weather they are sticky and difficult to walk over. In the following respects clay soils are good :—

(1) They are generally rich in the matters on which plants feed.

(2) They hold for a long time the water supplied

by rain or irrigation, and they can also take up a good deal of moisture from the air.

(3) They retain manure also much better than sandy soils.

(4) They are firm enough to support the plants growing on them in high winds.

They are bad however in the following respects :—

(*a*) They are very difficult to cultivate ; for when the soil is wet, it sticks to the implements and does not allow them to work freely, and, when dry, it becomes so hard that implements cannot stir it well.

(*b*) They are unfit to be ploughed for several days, after even a fairly heavy shower of rain.

(*c*) They do not absorb water fast enough ; consequently, when there is heavy rain, water either lies on the surface or flows off uselessly, carrying away with it some of the valuable portion of the soil. In both these cases, the soil is much injured.

(*d*) A very stiff clay soil is not well suited for irrigation, for, unless water is applied with very great care, the land will be spoiled by stagnant water, or will become saltish ; that is, 'kalar' or 'tchoudu.'

The improvement of clay soils.

Clay soils thus have certain advantages and certain disadvantages. The more clay there is in a soil, the greater the disadvantages. A fair proportion of sand and clay is, therefore, very important. An excessively stiff clay soil may be improved in the following ways :—

(1) By the addition of sand. About 40 or 50 cart loads may be applied per acre, spread uni-

formly over the land and mixed with the soil by ploughing.

(2) By applying lime. From 1,000 to 2,000 Madras measures of slaked lime in powder may be applied per acre on the surface.

(3) By paring and burning the soil, which is done by scraping the soil one or two inches deep; gathering the scrapings into heaps here and there; burning the heaps slowly with brushwood or other vegetable refuse, and then spreading the burnt soil evenly over the land.

(4) By applying fresh unrotted cattle manure.

(5) By applying green plants of various kinds, or better still, by growing a crop, such as horsegram, and ploughing it into the soil as soon as the crop flowers. This is called green manuring.

(6) By underground drainage.

The characters of sandy soils.

The characters of these soils are generally the reverse of those of clay soils. They are good in those points in which clay soils are bad and bad where clays are good. They are called free soils, because they do not stick to the implements of cultivation working in them. They are called light soils, because little force is required to draw implements through them. They are called open soils, because they let water pass directly through them and do not allow it to stagnate on them. They are called hungry soils, because they are generally poor in plant food and part with manure and moisture too easily. Pure sand is hard, gritty, and does not hold together when wet, and is generally the opposite of clay. Sandy soils may be improved;—

(1) by the addition of clay,

(2) by application of well rotted manure,
(3) by green manuring,
(4) by being planted with trees, and
(5) by warping.

Loams contain a nearly equal amount of sand and clay, and thus they have the best characters of both sandy and clay soils without their disadvantages, and the nearer they approach to clay loams, the more valuable they are.

Lime or marly soils are sometimes grey in color, and sometimes nearly white. They are generally sedentary soils, and are seldom very good; but in cool climates, where rainfall is frequent and gentle, the pulse crops, indigo, and certain other plants which require much lime, grow well on them, especially if the soil is fairly deep.

Soils in this country are, however, most commonly classified according to their color. The following are the chief sorts so classified :—

Black-cotton soil—is found extensively in the Ceded districts and Kurnool, Tinnevelly, and Coimbatore. It is generally free from stones; but a layer of small round pieces of limestone is sometimes found below the soil. In dry weather, it is generally hard and full of cracks; but in rainy weather, it is very sticky and difficult to cultivate. The soil is generally several feet deep, but sometimes it forms only a thin layer. One hundred parts of this soil contain from 4 to 7 parts of organic matter, and it has much power of taking up moisture from the air and continues moist for a long time. Cotton and cholum are the crops most commonly cultivated on this soil. Wheat and indigo are also extensively grown on it. It may be improved in the same manner as other stiff clay soils.

Red Soils.—The color of these soils is due to iron

rust. This is very useful in a soil; it takes up moisture from the air and is required to give the green color to plants. Red soils, if clayey, are not generally good; such soils, if they contain an excess of clay, being quite barren. Red soils containing a fair proportion of sand are usually fertile.

Light-colored soils—are generally of a pale yellow color, neither dark colored nor red. They are generally poor in organic matter. Organic matter is a very important thing in soils in a hot country. The larger the proportion of it there is in a soil, the greater will be its power of taking up moisture from the air, as well as its power of retaining rain-water or irrigation-water and thus of supporting plants in dry weather.

Salt land and its improvement.

A soil which is whitish in color may contain too much lime. It is then called in Tamil "Chunampu kalar." A soil may be white owing to an excess of salt. It is then called in Tamil "Ooppu kalar." The salt found in excess in such land is not only the salt we eat, but also another kind which is used by the washermen to wash clothes with. The impure salt is called in Tamil 'Pooneer,' 'Oovarmannu' and 'Saramannu.' Any salt which when mixed with water becomes invisible is called a *soluble salt*. If 100 parts of any soil contain more than 2 parts of soluble salts, the soil cannot generally be fertile. Salt lands may be improved:—

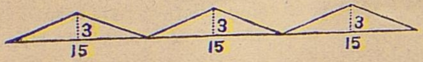
(1) by the addition of a large quantity of organic matter,

(2) by the addition of sand, especially if the surface soil is clayey,

(3) by the repeated cultivation of such crops as ragi, cocoanuts, casuarinas, &c., which are salt feeders,

(4) by drainage, especially under-drainage.

As it is very difficult in this country to provide under-drainage, the following method of surface drainage may be adopted for improving salt land. The land should be divided into a number of beds with sloping sides, each about 15 feet wide at the bottom and about 3 feet high in the middle as shown.



Cocoanut trees can then be planted on the crest of each bed, and ragi cultivated on the spaces between the trees. In the hot season, the salts gather at the surface, and when rain falls, will be washed down the slopes into the drains between the beds. A deep drain dug across the end of these beds at one side of the field will carry off the water containing the injurious salts from the field.

If a soil is barren, this may be owing to various causes :—

(1) There may be too much sand, clay, lime, organic matter, soluble salts, or iron which has not completely rusted in it.
(2) The soil may be very thin with a hard rock below.
(3) The soil may contain an excess of water which has no means of escape.
(4) The soil may be sour.
(5) Some particular kind of plant-food may be very deficient.

A soil is said to be 'sour' when it contains certain acid substances in such quantities as to render it more or less unfit to support plants. Plant-food is the matter required for the nourishment of plants, and will be more fully referred to hereafter.

CHAPTER IV.

Climate and Rainfall and the Importance of Storing Water.

Favourable conditions of climate.

A fairly cool climate and good rainfall are required to enable the farmer to be successful. It would be well if every part of the Presidency were as cool as Bangalore, for there not only do all the crops grown in other parts of the Presidency thrive, but also a variety of valuable crops, such as potatoes, apples, grapes, &c., which cannot be successfully cultivated in any district in the plains. In such a climate as that of Bangalore crops do not need irrigation as much as in the other places. The excellence of the Mysore sheep is chiefly due to the coolness of the climate. Silk culture can be successful only in a cool climate, such as that of Mysore.

Unfavorable conditions of climate.

Something, however, may be done to improve the climate of other parts of the country by planting trees. The reckless cutting down of trees tends to make the climate hot. On the other hand, the climate is rendered cool and equable by increasing the number of trees in the place largely. Very strong winds are injurious to agriculture, for they blow down tall growing crops such as plantains, cholum, &c. If such wind be hot and dry, it is still more injurious, for it dries up the moisture in the soil as well as the water in tanks and streams very rapidly. Very cold dry wind has a similar effect and is unfavourable to the growth of crops and to the health of animals.

The seasons in the Presidency.

About April or May, a strong wind accompanied by rain begins to blow on the Malabar coast, from south-west to north-east. This is called the south-west monsoon. The Western Gháts stop the greater part of the rain; but more or less of it passes on and falls in every part of the Presidency. About September or October, the wind changes and blows from north-east to south-west. This is called the north-east monsoon, and continues till January or February. The rains of this monsoon are also stopped to some extent by the Eastern Gháts and chiefly fall on the Coromandel coast and the more southern portions of the Presidency. When these rains cease, the weather is usually dry and fine till the April or May following. The south-west monsoon rains are hot weather rains, and the north-east monsoon rains cold weather rains. There are accordingly hot weather crops and cold weather crops, which will be spoken of hereafter. Rainfall* is heaviest on the Malabar coast, fairly heavy on the Coromandel coast, and lightest in the interior parts of the Presidency, such as the Ceded Districts. The cattle in Malabar and South Canara are very few in number and very poor in quality, because the climate there is very damp and proper shelter is not provided for the animals.

* *Measurement of Rainfall.*—If the rain-water collected on a perfectly level surface without flowing off, without sinking into the ground, and without evaporating is one inch deep, the rainfall is said to be one nch. The instrument used for measuring the rainfall is called a rainguage. A simple rainguage may be made as follows:—

Make a zinc funnel with a circumference of $13\frac{3}{4}$ inches, with a hole at the bottom, and take another vessel with a mouth into which the funnel fits tightly, and place the

Characters of rainfall.

Not only is a good quantity of rainfall to be wished for, but also a good quality, that is, the rain should fall in gentle and frequent showers. Thus, the total rainfall in a place per annum may be about 80 inches. The quantity no doubt seems large, but unless it is known how and when it fell, a mistake may be easily made as to the character of the climate. The number of days on which the rain fell during each week, and the duration and amount of the rainfall each time, must be known. What is required is that early in the season enough

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vessel on a perfectly level surface well away from walls, houses, or trees. This is the receptacle, and the rain falling into the funnel will pass into the vessel below, and can then be measured.

To measure the rainfall—make a zinc vessel a foot long with a circumference $\frac{1}{16}$ of an inch less than 4 inches ($3\frac{15}{16}''$), and mark on the inside a colored line from top to bottom. Divide this line into 64 equal parts, and mark and number the divisions from bottom to top. If the rainwater collected exactly fills the measure, the rainfall will have been exactly one inch, and each division denotes one sixty-fourth of an inch.

The number of Madras measures of water contained in an inch of rain collected on an acre of land may be calculated as follows:—

1 acre = 4840 square yards, or $4840 \times 9 \times 144$ square inches. An inch of rain over an acre $= 4840 \times 9 \times 144 \times 1$ cubic inches. A Madras measure = 100 cubic inches. Therefore in one inch of rainfall on an acre there are $\frac{4840 \times 9 \times 144 \times 1}{100}$ or about 62726 Madras measures. Since a gallon = about $277\frac{1}{4}$ cubic inches, this rainfall is also equal to $\frac{4840 \times 9 \times 144 \times 1}{277\frac{1}{4}}$, or about 22,600 gallons. A gallon of water weighs about 10lbs. Therefore an inch of rain over 1 acre weighs 226,000 lbs, or roughly 100 tons (1 ton = 2240 lbs.)

A wet day is any day on which there has been rain enough to be measured; the rainfall should be measured at some fixed hour every morning.

rain should fall to soak the land sufficiently to allow of ploughing, and afterwards there should be frequent light showers to keep the crops growing all through the season. An inch of rain falling in April in several showers would be of little use; and a heavy shower early in September followed by three or four weeks without a drop would be unfavourable weather. The absence of rain during the harvesting season, and also when crops are in flower and the grain is about to be formed, is to be hoped for. Rainfall should neither be too light nor too heavy and sudden. In the former case, the water dries up as soon as it falls, especially under a hot sun, and in the latter case, it has not time enough to soak into the ground but flows off the surface of the land, carrying away with it a portion of the good soil. Very heavy rain also makes the soil hard; but it also, although not so useful for dry land as gentle and frequent showers, serves to fill the irrigation tanks.

Storage of water.

In this country rain generally occurs in heavy showers, and long intervals of dry weather are very common. So every means of storing the rain water that falls must be taken. By putting a bank across any extensive sloping ground, the rain water falling on the slope may be stored and a tank be formed. This is very easily done in hilly places. To prevent the water of rivers from flowing uselessly away to the sea, channels are dug to take off part of the river water and store it in tanks, or to turn it on to the fields and so water them. If the hills near the sources of rivers and their banks be covered with trees, these prevent the rain-water from rushing away rapidly to the sea, and make it soak into the ground, and form good and lasting springs. The heavens supply rain to the soil gratis, and rain

brings to the soil certain very valuable matters, which are much needed by plants and which will be spoken of hereafter; so every ryot should endeavour to cause as much of the rain as possible to soak into the soil, and for that purpose he must have his land well tilled, and enriched with organic matter.

Land kept in such a condition will also benefit greatly from the dew at night. Dew is beneficial to all crops, and especially to pulses. If the sky is cloudy at night, no dew will fall.

CHAPTER V.

Tillage and Tillage Implements.

Tillage comprises all the operations of cultivation.

The objects of tillage.

The objects of these operations are:—

(1) to make the soil soft and mellow, so that the roots of plants may go deeply into the ground, and thus be able to obtain nourishment from a large quantity of the soil, and also to fix the plants firmly in the ground;

(2) to admit air freely into the soil, so that it may make the matter which serves as food for plants fit for their nourishment, and also render harmless other substances which would otherwise injure plants;

(3) to clear away the weeds and thus clean the land;

(4) to make the soil absorb rain and irrigation water freely.

The soil and the sub-soil.

It has already been pointed out that the earthy covering of the land is called the soil, but on the farm it is only that upper portion of this covering which is usually stirred by the plough which is called the 'soil,' what lies below being called the 'sub-soil.' Sometimes the subsoil and the soil resemble each other very closely. Usually, however, the sub-soil is much lighter in color than the soil, and differs considerably from it in fertility. The value of a soil depends greatly on the character of

the sub-soil. When the sub-soil is a stiff clay, or is full of stones and gravel, or rests upon hard rock, the soil is usually an unproductive one; for the roots of plants penetrate a stiff clay with great difficulty and are turned back by hard rock, or when the sub-soil consists largely of stones and gravel, manure applied to the soil is easily washed down so deeply into the sub-soil as to be useless to crops. As such a soil so soon again needs fresh supplies of manure, it is known as a 'hungry' soil.

Tillage instruments.

Tillage operations are usually confined to the soil. The instruments of tillage are of two kinds, viz., implements and tools. Those worked by cattle, such as the plough, are called implements; those worked by hand, like the mammaty, are called tools. The ordinary ryot has very few tillage implements. In fact in many districts the native plough is the only implement he has. In the Ceded districts, however, the ryots often have several sorts of ploughs and other implements which they use in cultivating their land.

The work of the plough.

A plough, strictly speaking, should not only loosen the soil, but also partly turn it over, so that the lower portions of it may be exposed to the air. The native plough does not do this, but simply stirs the soil. It is therefore not a real plough. The advantages of turning the soil over are:—

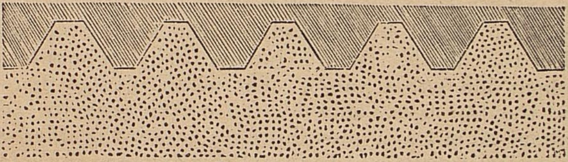
(1) that every part of the soil is exposed to the air and rendered soft and free thereby;

(2) as the stems and leaves of weeds are covered up by and mixed with the soil turned over, they soon rot, and as the roots of the weeds are exposed to the sun, they are soon killed;

(3) the worms, caterpillars and other insects injurious to crops are exposed and picked up by crows or killed by exposure.

The native plough.

When a native plough has only once been driven over the land, hard masses of unmoved soil will be found, if the furrows be dug across. It is thus clear that the work of the native plough is imperfect. To remove the masses of land left unploughed in the first instance, the plough must be worked crosswise. Of the masses of unploughed soil, only half is now loosened. In like manner, each ploughing is only half done. But practically, when the soil has been ploughed about four or five times, the whole of the soil will have been loosened. Although the soil is not wholly stirred in the first ploughing, to one who simply looks at the surface, the whole will seem to have been stirred. The reason why the work of the native plough is imperfect is that the furrow made by it slopes on both sides from the top to the bottom, so that a section of the furrow has nearly the shape of the letter V. Between every two furrows of this kind a piece of unploughed land is left having also a section like the letter V turned upside down, as shown in the annexed diagram :—



N.B.—Dotted portion=unploughed soil.

The working part of the native plough has a flat surface above, and ends in a sharp edge below. When the plough is at work the flat surface is pressed against the soil, and hence there is great resistance to the passage of the plough. The kind of native plough used in South Canara has not this defect. It is hollow at the bottom and has a sharp ridge above, so that the plough splits the soil with comparative ease and the loosened soil falls on either side. Soil sticks more to wood than to iron. The greater portion of the working part of the native plough being made of wood, the soil sticks to it; and the trouble in making the plough pass through the soil is great.

The work done by the native plough.

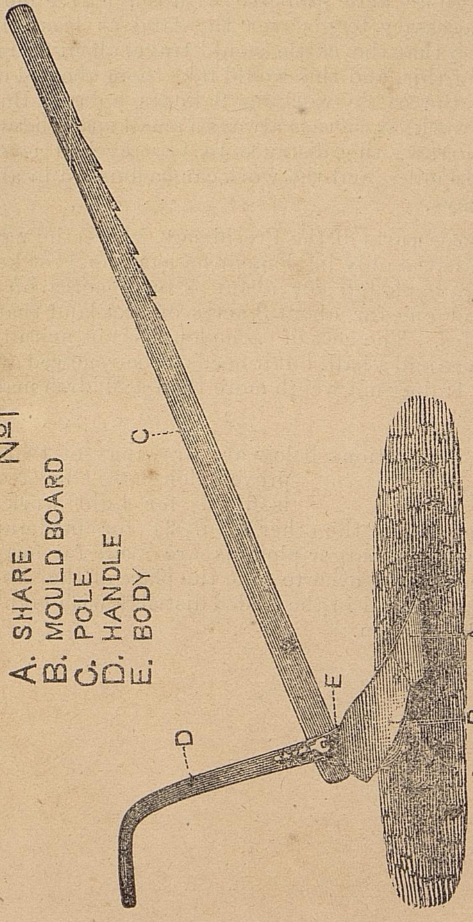
No doubt the native plough does not require very strong cattle as it only does a very small amount of work at a time. In soils of moderate stiffness, the furrow it makes will not be more than 5 inches wide at the top, $\frac{1}{2}$ inch wide at the bottom, and 4 inches deep. The average width of the furrow is $\frac{5+\frac{1}{2}}{2}$ or $2\frac{3}{4}$ inches. This multiplied by the depth gives the area of the section of a furrow, which is thus equal to $2\frac{3}{4} \times 4$ or 11 square inches. When the soil has been wholly moved by repeated crossings, the number of cubic yards of soil moved will be found by multiplying the area of an acre by the depth, viz., 4 inches. This amounts to about 538 cubic yards. The width of the furrow at the top being only 5″, the cattle have to walk about 20 miles in ploughing an acre if the furrows are close together. To travel this distance the cattle will take about 12 hours, and in going over the distance they will stir about 300 cubic yards of soil; but

to plough an acre properly with the native plough it is necessary to go over the land at least three times, so that the cattle would travel about 60 miles in doing this, and this would take them about 4 days to do, the cattle working 9 hours a day. But in actual work, as there is always a small space between each furrow, the distance to be travelled is only about 40 miles, and the work can be finished in about three days.

In those parts of the Presidency where the native plough is the only implement he has, the ryot keeps a separate plough for about 5 or 6 acres of dry land and one for about 3 acres of wet land that he cultivates. The cost of each plough is not more than one rupee and a half, but it needs to be renewed every year. It does not weigh more than a Madras maund (25 lb.)

Improved ploughs.

The illustrations below are drawings of two improved ploughs. One (No. 1) is fitted for light work on ordinary soils, the other (No. 2) for moderately heavy work. Larger ploughs are made for heavier work, and some even to take the place of the 'Pedda Madaka' worked in the Ceded districts with eight or ten yoke of oxen.

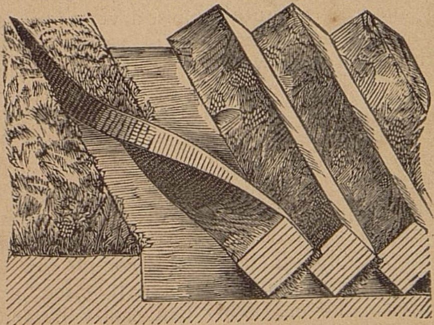

No 1
A. SHARE
B. MOULD BOARD
C. POLE
D. HANDLE
E. BODY
C
D
E
A
B

PAGE NO- 31, 32 MISSING IN ORIGINAL

are the share, mould-board and coulter. The share cuts the soil horizontally, and the coulter vertically: the soil to be turned is separated from the firm land by means of the share and coulter, and turned over by the mould-board. The trench made by the plough is called the furrow, and the earth removed from it and turned over is called the furrow-slice.

The working parts of improved ploughs are usually made of iron or steel. Sometimes they are made of cast-iron, but, though this is cheaper than wrought iron or steel, it is, from its brittleness, more liable to be broken, and as there is difficulty in replacing cast-iron parts, and as they cannot be repaired, it is better not to have them made of it.

In the next diagram, the furrow made by an improved plough is shown :—



In this, the sides of the furrow do not slope towards the bottom, and the bottom of the furrow is level. If the condition of the soil and the weather be such that the native plough makes a furrow

with the width and the depth stated above, an improved plough will make a furrow about 7 inches wide and 5 inches deep. A section of such a furrow is 35 square inches, and the number of cubic yards of soil stirred in ploughing one acre is about 672 cubic yards, against 538 cubic yards moved by the native plough. In ploughing one acre with an improved plough the cattle have to walk about 14 miles, and this will take them about a day and a third, as some time is lost in turning at the ends of the field, or headlands.

The work done by an improved plough.

The weight of improved ploughs is, for No. 1 about 30lb and for No. 2 about 80lb; but it must be borne in mind that the weight of a plough has little to do with the force required to draw it. If a large army invading a country have to enter it by a very narrow mountain pass, a very few soldiers stationed at the entrance could resist the enemy successfully, for they would deal only with a few at a time. So, if an implement be made so that it can be resisted only by a comparatively small quantity of the soil at a time, it can be forced through the soil with comparative ease. This is why the parts of implements which pierce the soil are wedge-shaped. The improved plough does not present a flat surface to the soil like the native plough. The reason why the improved plough requires stronger cattle than the country plough is that it usually does far more work than the latter. This can easily be tried by tying ropes first to a country plough and seeing how many people can draw it through the soil when it ploughs 4 inches deep, and afterwards doing the same with an improved plough. There will not be much difference in the force required, but in the work

done there will be a great difference; one is finished and the other only half done.

The cost of working an improved plough.

The cost of work done by an improved plough compared with that of the work done by a native plough must be considered. The cost of an implement must not be confused with the cost of *work done by* it. The cost of a railway is enormous compared with the cost of a bullock cart. The fare is not less than four annas for a 3-mile journey in the latter, and the cart-man makes but little profit for himself, though the fare is more than an anna a mile. A Railway Company, getting scarcely 2 pies a mile, makes a good profit. Thus the cost of an improved plough (No. 2) is about Rs. 20; this amount lent to any one may yield as interest 12 per cent. per annum; that is about Rs. 2-6-7. This interest may be taken as part of the cost of the work done by the plough. On dry land there is work for the plough for not more than about 60 days during the year. The interest chargeable for each day is therefore Rs. $\frac{2\text{-}6\text{-}7}{60}$ or about 7 pies. The cattle required for the plough will not cost more than Rs. 80 the pair, even in places where they are very dear. The interest per annum on Rs. 80 at 12 per cent. is about Rs. $9\frac{1}{2}$. As the cattle may be employed in some work or other for most of the year, the interest chargeable daily is Rs. $\frac{9\text{-}8\text{-}0}{300}$, or about 6 pies. The charges for repairing the plough may be about Rs. 2 per annum, or Rs. $\frac{2}{60}$ = about 6 pies daily. The plough lasts at least for 10 years and the Rs. 20 spent to buy it is thus lost in 10 years. The annual loss is thus Rs. 2; and the daily loss Rs. $\frac{2}{60}$, or about 6 pies. This is said to be the charge

for the wear and tear of the plough. In like manner the daily charge for the wear and tear of the cattle is Rs. $\frac{80}{10 \times 300}$, or about 5 pies. The ploughman's wages may be 3 annas a day. The keep of cattle will not cost more than 6 annas a day. The total daily cost of work is thus as follows :—

	A.	P.
Interest on outlay for the plough	0	7
Do. for cattle	0	6
Charge for wear and tear of the plough ...	0	6
Do. do. of cattle	0	5
Repairing charges	0	6
Keep of cattle	6	0
Ploughman's wages	3	0
Total Annas ...	11	6

In a day the plough, it has been said, will plough $\frac{3}{4}$ acre of moderately stiff soil. The cost of ploughing an acre 5 inches deep, that is, the cost of stirring and turning over 672 cubic yards of soil is therefore about one rupee.

The cost of working a native plough.

The cost of the work done by the native plough must next be calculated. The daily charges for interest, wear and tear, and repairs of the plough are so trifling that they may be overlooked. The pair of cattle required for the native plough will cost Rs. 20 at least, even in places where cattle are very cheap; but, whatever be the quality of cattle, they all consume nearly the same quantity of food. An athlete scarcely consumes more food than a weak pot-bellied man. Of course, cattle when working an improved plough may be given food of better quality. If the charge for the keep of these cattle is 6 annas a day, a charge of 5 annas is a fair one for the keep of the cattle required for the native

plough. The ploughman's wages are 3 annas a day. The total cost per day is therefore a little more than 8 annas. It has been shown that the native plough stirs 538 cubic yards of soil in three days. At 8 annas per day, the cost of moving 538 cubic yards is Rs. $1\frac{1}{2}$. The cost of moving 672 cubic yards of soil, the amount the improved plough does for one rupee, will be Rs. $\frac{1\frac{1}{2} \times 672}{538}$ = about Rs. 1-14-0, or nearly double.

Objections to the use of improved ploughs.

One improved plough will suffice for the cultivation of at least 15 acres of tolerably stiff dry land. If a ryot's holding is larger than this, then only will the larger improved ploughs prove very advantageous; for small holdings the smaller and less expensive ploughs are more suitable than the larger ones; if the holding is only one or two acres in extent, there will not be enough work for a single plough. The ploughman working the larger ploughs is much farther off from his cattle than when guiding a native plough, but this greater distance causes little inconvenience and it is not felt with the smaller ploughs. One real objection to the use of improved ploughs is that the village blacksmiths are not always able to repair them; but as the share is the part which requires most frequent repair, and any village smith is quite able to repair it, this difficulty is greatly reduced. The mouldboard is the part which the village smith is not usually able to make; a new one is only required at very long intervals, and then may be easily sent for from one of the foundries at Madras. With a little trouble a village smith can easily learn even to make an improved plough.

In working the native plough the ploughman

presses it down with all his might to make it go deeply; but in working an improved plough it must not be pressed down at all, or it will do very bad work, as pressing on the handles lifts the share out of the ground.

Tillage and ploughing; the difference between.

There is a great difference in meaning between 'tillage' and 'ploughing.' Tillage or cultivation means the stirring or loosening of the soil. Ploughing means not only the loosening of the soil, but something more; that is, turning it over. Ploughing is a special kind of tillage. There are many other tillage operations, such as grubbing, harrowing, rolling, which are not 'ploughing,' because the soil is not turned over in these operations, but is simply loosened or pulverised; they are all however followed in order to attain the end of all tillage, which is to make a deep, fine, moist and clean seed-bed.

The benefits of deep tillage.

Deep tillage is extremely beneficial. On deeply tilled soil the roots of crops can go down deeply into it and obtain a good supply of moisture and nourishment. By deep cultivation the store of plant-food is increased, as the air enters amongst the loosened subsoil and makes the plant-food in it fit for the nourishment of plants. The value of deep cultivation, in that it prevents the excessive rise of injurious salts to the surface, has already been explained. Besides this, when the roots of plants strike far down into deeply cultivated soil, they are better protected from the scorching heat of the sun, and deeply cultivated soil can absorb and retain more rain and dew than that, the tillage of which has been shallow, only.

The dangers of deep ploughing.

Though it is seldom, under any circumstances, wrong to stir and loosen the soil of any field deeply, land should not generally be ploughed very deeply all at once. If the subsoil is poor, excessively stiff, very open, or contains matters injurious to plants, and is ploughed up, the bad subsoil will be brought to the surface and do harm to the field; such a soil should be rather deepened little by little every year, the depth of ploughing being increased every year, say, by $\frac{1}{2}$ inch. The raw subsoil when brought to the surface in small amounts at a time will not then injure the surface soil, but is soon brought to a good state by exposure to the air. If the subsoil be very open, it should not be disturbed in any way.

The use of the subsoiler.

Even when the subsoil is not in good condition, much good may be done by simply stirring it deeply, as both water and air will then pass freely into it and improve it. For this purpose an implement called a 'subsoil plough' or 'subsoiler' is used, which simply loosens the subsoil, but does not turn it over. If, after making a furrow with an improved plough, such an implement be worked in the furrow, thus stirring the under soil, the operation is called subsoiling. As the native plough simply stirs the soil, but does not turn it over, it may be worked behind an improved plough in the furrow made by it, and thus effect subsoiling; but the subsoil will not be completely stirred then. With two improved ploughs, land may be subsoiled thoroughly by removing the mould-board from one of the ploughs and working it in the furrow made by the other plough. If an improved plough *with the mould-board* on is worked in the furrow made by another improved

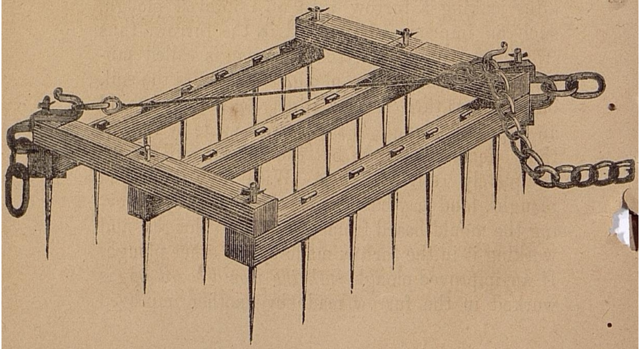
plough, so as to bring the subsoil up to the surface, the operation is called 'trench-ploughing'. It may be easily understood from what has been said under what circumstances trench-ploughing is not advisable.

Condition of soil necessary for ploughing.

A soil should never be ploughed when it is wet; for if this is done, it will then be turned over in slices, which, on drying, will harden like bricks, whilst the treading of the cattle and pressing of the ploughs will knead it into a paste, and it will be very difficult to reduce the hard masses to powder, and crops will not thrive on the land afterwards. Unless the soil is fairly moist, it cannot be ploughed; for, if an attempt is made to plough a soil which is too dry, the plough will hardly penetrate the soil, but its working parts will be much worn.

The harrow and its uses.

The Harrow is an implement consisting of a framework with teeth fixed below, which is drawn over the land to level it, break up the clods into fine powder, and drag out the weeds. The annexed is a diagram of a simple harrow.



If an improved plough be used, a harrow is very useful for levelling the land after ploughing. If ploughed land is left exposed in a rough state to a hot sun for a long time, the moisture in the soil will soon be lost; so, no time should be lost in harrowing it after it is ploughed, if the sun is hot and there is no probability of more rain falling soon, unless it is simply wished to expose the soil to the air and sun to kill the weeds, in which case it should be left untouched. The ryots in some parts of the Presidency use a rough kind of harrow with wooden teeth; it may be used for covering the seed after sowing, but it is not of much use for crushing clods.

The roller and its uses.

A Roller, like the stone rollers used on the roads, but made of heavy wood, is often useful for crushing clods; for making the surface of the field smooth; and for making the soil compact so as to check the evaporation of moisture. It is well to roll deeply ploughed land previous to sowing indigo, ragi, and other crops, the seeds of which are small; for if the soil is not rolled, the seeds may sink too deeply and then may not germinate. Instead of a roller a heavy plank or log is often drawn over the land for the same purposes.

Ploughing, harrowing and rolling are the chief operations of tillage in making land ready for sowing, or in other words in the preparation of the seed-bed. The proper use of these can only be thoroughly learnt by experience, and cannot be taught in the school-room.

Ridging.

In some cases, especially for irrigated crops, an operation called ridging is very useful.

The process is as follows :—After making the soil loose and fine enough and clearing away the weeds, a furrow is made at one side of the field with an improved plough. If this runs from north to south, the mould-board being placed on the right-hand side of the plough, the soil will be thrown over to the right-hand side, that is, towards the west. On reaching the headland, the plough is turned to the right, and a furrow made about a foot and a half from the first. The second furrow-slice will then be thrown towards the east against the first furrow-slice and a ridge is formed. Then, on reaching the headland again, by turning the plough to the left, it will work in the last furrow till the opposite headland is reached, and then again turning to the right, and making a furrow again a foot and a half from the last one, another ridge will be formed, and so on.

The importance of ridging will be explained hereafter. Before sowing seed on the ridges, the crests or tops of the ridges should be made even with a hoe or other tool.

Tools used in cultivation.

The tools employed for tillage in this country are chiefly the mamatty, hand-hoe, pick-axe, and crow-bar. The mamatty is chiefly used in garden cultivation, for guiding irrigation water, digging drains, making embankments, &c. The hand-hoe is used for loosening the soil amongst growing crops. Mamatties and hand-hoes must be worked in such a manner that their blades may be self-sharpening; that is, the blades must dig the soil obliquely. In digging or hoeing, treading on the loosened soil must, as far as possible, be avoided, or the soil will be again made compact and the weeds be buried. The pick-axe is used for digging hard soil and for loosening the soil between the lines of crops when these are close together. The crow-bar is used for digging land a foot or two deep for getting rid of deep-rooted grasses. It is used for that purpose on the black soils in some places. The

digging fork is a useful tool which may be employed in garden cultivation, and for digging the interspaces between plantains, sugarcane, &c. It is useful also for harvesting such crops as ground-nuts, potatoes, sweet potatoes, turmeric, &c., the produce of which is borne underground. An improved plough is also of great use in digging up such a crop as ground-nuts, potatoes, &c.

CHAPTER VI.

The preparation of dry land for sowing and the sowing and treatment of crops thereon.

The seed-bed.

The preparation of a good seed-bed has been shown to be the object of all tillage. By a good seed-bed is meant land in proper or fit condition to receive the seed to be sown. Different seeds require the seed-bed to be in different states. For all, it should be clean and moist. For some, it must be very fine, but need not be very deep; for others, it should be deep, but need not be very fine. Generally speaking, it should be clean, moist, deep and fine; the degree to which the two latter conditions are carried varying somewhat for different crops.

The preparation of land for sowing.

To obtain these conditions, no land should be tilled unless it be sufficiently, and at the same time not too, moist. Dry land depends for its moisture on the rainfall alone, and the rain does not always fall just when it is desired. It is therefore advisable to take advantage of every fall of rain to push on the preparation of land for seed sowing. It not infrequently happens that rain comes in showers not long after harvest, or long before the time for sowing has arrived. The moisture these showers bring to the soil should be utilised for ploughing it up, so that the land may be left exposed in a rough state to the sun and air for as long as possible before the time for sowing arrives. Land should always be ploughed early, and advantage should be taken of every chance to prepare it in good time. If this early tillage be deep, it is especially beneficial, for then a large quantity of soil is exposed to the beneficial action of the air, and the roots of many weeds will be dried up and killed.

The effect of deep tillage.

Deep tillage also is almost always of great importance on dry land, as deeply tilled land remains moist for a longer period in dry weather than that which has only received shallow tillage. This is seen when a well or a deep pit in the middle of a field has been filled up, for then it will be found that any crop cultivated in the field during a dry season will continue far greener and flourish better where the well or pit was than in other parts. Deep cultivation may be effected, as has been shown before, by means of subsoiling; but it is seldom worth while to subsoil land for such inferior crops as varagu, shamy, &c., though such valuable crops as cotton, indigo, or oil-seeds will pay for being subsoiled.

Details of tillage.

The number of ploughings necessary to prepare land for sowing depends on the condition of it; but generally after it has been ploughed in one direction, it should be cross-ploughed and then the clods must be broken down, and the land levelled, by working a harrow once, twice, or thrice, across the field. But if the land be ploughed in a proper state of moisture, few clods will be formed, and if any are and it is likely to rain, no trouble need be taken to break them, as a fair shower of rain will make all of them crumble. If rain cannot be waited for, and seed must be sown at once, the larger clods may be broken by hand with mallets or to some extent, by the use of a roller. The rest of the work must be done with the harrow. Generally speaking, it is well to avoid ploughing immediately before sowing and better to complete the final preparation of the seed-bed with the grubber*

* The grubber is an implement consisting of a number of teeth or tynes, on which shares are fixed, which are attached

and harrow: by this system a great deal of expense is avoided.

Conditions necessary for seed sowing.

Just as every fall of rain should be utilised to prepare a good seed-bed, so when the proper season for sowing arrives, the first favorable rain should be made use of for sowing. The land should be finally cleaned, and the seed sown as rapidly as possible. Land should usually be sown soon after it has been prepared; for otherwise it will soon settle, that is, become as hard as before, and will have to be prepared again. Seed must not be sown either when the soil is too wet or too dry, nor when it is expected that very heavy rain will fall soon after it has been sown, for such rain hardens the soil at the surface and the seed often fails to grow, as the sprout cannot push its way through the hardened surface.

Systems of sowing seed; broadcasting.

Seed may be sown in one or other of three ways. It may be scattered by hand on the surface of the land. This is called broad-cast sowing, and is generally the worst method of sowing seed for the following reasons:—

(1) As the seed does not fall in regular lines, the soil between the growing plants cannot be properly loosened and cleaned without great labor.

(2) In some places the seeds will fall too closely, and in others too far apart. If plants grow up too near each other, they struggle with each other for the food which exists in the

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to a frame-work, and when drawn through the soil stir it without turning it over. Such is the *Gorru* of the Ceded Districts, when worked without a *Zadigam*.

small quantity of soil between them, and they also shade and injure each other; or, if they are too far apart, the soil is not made thorough use of; and in either case the produce will not be large.

(3) It is difficult when seed is sown broadcast to cover it properly, and some of it will lie on the surface and is there scorched by the heat of the sun, or picked up by crows and other animals; whilst other seeds are buried too deeply and do not germinate.

(4) From the last cause, and as it is not easy to sow a small quantity of seed broadcast over a large area, an unnecessarily large quantity is used, and thus seed is wasted.

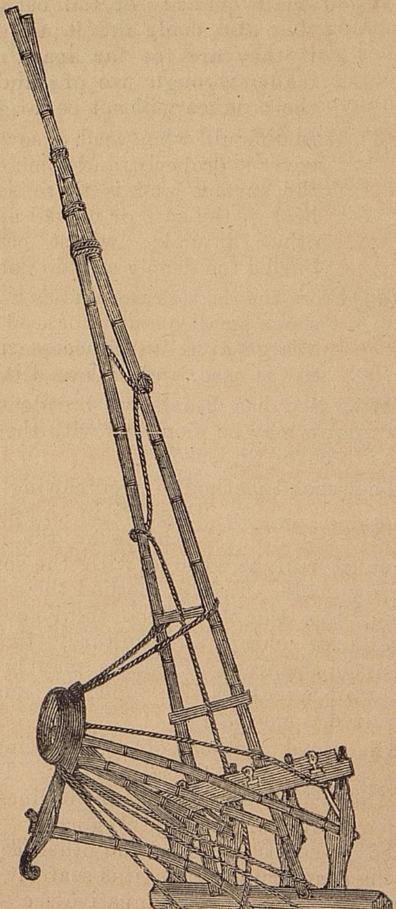
After seed has been sown broadcast, a very shallow furrow may be ploughed with the native plough so as to cover the seed.

Dibbling in a furrow.

The second method of seed sowing is to drop the seed in a shallow furrow made by the native plough, when it will be covered with the soil of the next furrow made. In this method the seed is apt to be either too thickly or too thinly covered; but it admits of cheap interculture, that is the soil between the lines of plants may be loosened and freed of weeds easily; and the amount of seed required is small.

Drill sowing.

The third method of seed sowing is the most satisfactory. In it the seed is sown in lines by a machine called a drill, in Telugu "gorru." The latter is chiefly used in the Ceded and other Telugu districts. In the southern districts it is scarcely known. The annexed figure shows the native seed-drill.



A pair of cattle and two coolies are required for working it. One cooly drives the cattle and the other places the seed in the machine whilst it is moving. This must be very carefully done, for, if too much seed is put in at a time, the tubes going down from the seed cup will be choked, that is, filled with seed, and no seed will fall to the ground, and the mistake can only be discovered after the seed has sprouted, when, if it is not sown continuously, intervals bare of crop will be left in the field. By this method the seed is sown regularly in lines, and if care be taken, a very small quantity of it will suffice.

Regulation of the amount of seed.

Plants growing in fertile soils grow vigorously and attain a large size, with plenty of leaves and spreading branches. If seeds are sown too closely together on such soils, the plants interfere with each other's growth. Therefore on rich soils seed should be sown comparatively thinly, and on poor soils more thickly. If it is intended to make plants grow tall and not wide-spreading, seed should be sown thickly; for instance, the seeds of most fibre plants should be sown thickly, for if fibre plants have numerous branches there will be numerous knots in the stems, and the fibre will consequently be divided at these knots and be short. In hot and dry weather seed may be sown pretty thickly, so that the plants may shade the ground and protect it from loss of moisture.

The depth for sowing seeds.

In hot weather seed should be sown more deeply in the soil than when the weather is cold and damp, so that it may be better protected from the heat of the sun. Seed liable to be picked up by the crows, &c.,

should be sown pretty deeply. The depth at which the seeds of most field crops may be sown varies from $\frac{1}{4}$ to $1\frac{1}{2}$ inches according to their nature. The larger the seed, the more deeply is it generally safe to sow it. Very small seeds, such as indigo, ragi, tobacco, if sown deeply in the soil will not germinate satisfactorily; they should be sown almost on the surface, and the soil should be made compact before sowing them.

The importance of keeping land clean.

Never allow a single weed to grow on the land, if it can be helped. Crops not kept free from weeds cannot thrive; for both crop and weeds remove from the soil the same kinds of matter for their nourishment, and it is desirable that all the food in the soil should be available for the crop alone; besides which, weeds crowd and cramp the crop which it is desired to grow. A weed is any plant which the farmer does not desire to grow on his land. It must be understood that every weed, if allowed to grow, will produce a very large number of its own kind, which will likewise spread. Many people wonder how numberless weeds appear in a field without their seeds being sown; but some idea of how weeds spread may be formed if the manner in which the *Erukkam* plant (Telugu *jilledu*) spreads be observed. The *Erukkam* seeds with a number of cotton-like fibres proceeding from them on all sides may be noticed floating in the air. The wind carries them to and fro, and eventually they settle somewhere, and, if the spot be moist, will grow there. In the same way the seeds of many other weeds which are very small and light are carried from place to place by the wind, by birds and sometimes by flowing water, &c., and thus spread. A ryot may think that there can be no harm if weeds

are allowed to grow near hedges, on road-sides, channel-sides, &c., where there is no crop; but he should understand that it is a very bad practice to allow weeds to grow anywhere near his land, for the seeds of weeds may and will be carried to his fields without his knowing anything about it, and numbers of weeds will appear there. Although a ryot may be so careful as not to allow a weed to grow on his own estate, he will have plenty of trouble with weeds, if his neighbours are careless; for the seeds of weeds may be carried from their fields to his.

The economy of weeding.

Land is said to be foul when weeds grow luxuriantly on it. The expenditure of labor and money for cleaning foul land should not be grudged. The weeds must be removed by the root and should be rotted in pits, or if necessary, burnt. If land is once thoroughly cleaned, it will cause little trouble and expenditure for weeding afterwards. The weed which gives most trouble to the ryot on light soils is the bulb grass, called in Tamil *korai*. The roots of this weed are fleshy. The fragrant powder called *rabee*, which is used during the Moharram festival, is prepared from the dried roots. If the roots be cut into pieces, a plant may be produced from each piece. As the roots penetrate very deeply, it is very difficult and costly to clean the land, if the weed has been allowed to grow on it for a long time. On the stiffer and richer soils, the ryots in many places spend very large sums of money in removing deep-rooted weeds, such as *hariali* and *kundara*, by means of crowbars, or by the use of a very large plough drawn by five or six yoke of oxen, called in Telugu the "Pedda Madaka."

Hand-hoeing and Bullock-hoeing.

The weeds growing amongst crops may be removed either by hand-hoes or by bullock-hoes. Hand-hoes are like mamaties, but their blades are smaller and broader and their handles longer. Bullock-hoes are somewhat like ploughs, but are without mould-boards. A native plough may be used as a bullock-hoe. When a crop is very young and tender, or is high enough to be broken by the yoke if the bullock-hoe is used, or if the plants are not sown in lines, only hand-hoes can be used for weeding the crop; but at all other times it is well to use the bullock-hoe first, hand-hoes being afterwards employed to complete the work. Under a hot sun the weeds if left on the surface of the land after it is hoed will be killed; but if the soil be very moist and the weather cloudy it is well to gather the weeds and remove them. In hoeing land, care must be taken to avoid treading the loosened weeds into the soil, lest they should grow again. Land must not be weeded when very wet. It is of no use only cutting off the stems of weeds: they must be dug out by the roots. Under ordinary circumstances six men can hoe and clean an acre of foul land daily with hand-hoes, if the crop be sown in lines or drilled.

CHAPTER VII.

Wet Cultivation, or the growth of Paddy.

Definition of wet cultivation.

Wet cultivation is the tillage of land after it has been thoroughly submerged and soaked in water, so as to mix the soil and water thoroughly and evenly, and the watering of crops abundantly during their growth. Such tillage or the practice of reducing the soil to a soft mire is called puddling. Wet cultivation is practically only pursued in the growth of one crop —paddy.

The supply of water.

The large amount of water required for this system of tillage is obtained generally from tanks or river channels. A tank may be constructed by putting a bank across the outlet from an extensive slope so as to prevent the water of the rain which falls on the slope from running away. As the water in a river is generally much lower than the land to be irrigated, it is necessary to raise the level of the water by building a wall or dam across the river bed, called an *anicut*. The water is then turned aside from above the anicut and may be conducted to the land to be watered through channels, either directly or after being stored in a tank.

Laying out the land.

Land is laid out for wet cultivation by being divided into a number of plots one below another, each plot being perfectly level in order that it may be easily watered. Narrow banks are made round each plot, to confine the water. The ryots usually divide

their wet land into a large number of very small fields, so that the total space occupied by the banks is very large and is lost for cultivation. The loss is of course the greater if the land is valuable. In very small fields tillage is also inconvenient, as the cattle have to turn frequently. The larger each field is made, the greater will be the cost of levelling the field, but this does not matter much, if the land is very valuable as the saving in the labour of tillage thereafter will be great. Each field may be from $\frac{1}{4}$ to $\frac{1}{2}$ acre in area.

Preparing the land.

The commonest way of preparing wet land for sowing is first to water it plentifully and then to plough it repeatedly at intervals. Sometime before planting the crop, leaves of various kinds of plants, of which Erukkam (Tel. Jillédu), Pungam (Tel. Kanuga), wild croton (Tam. Kattamanakku) are considered the best, are trodden into the mire and then allowed to decay for several days : cattle dung, oil-cake, and other manures, if available, are also applied. Finally, the land is ploughed again, and levelled by means of a plank drawn over it by cattle. It takes nearly a month to finish the preparation.

Raising seedlings in a nursery.

Generally a small piece of land is first prepared thus and sown with paddy very thickly to make a nursery. The seed-paddy is in most cases made to sprout before being sown, by being kept damp and warm under paddy straw for about 3 days. When the young plants in the nursery are from 4 to 6 weeks old, they are pulled up and planted out on the land to be cropped, which has been prepared in the meanwhile in the manner described above. If the variety of paddy to be grown

be a 6 months' crop, the seedlings may be transplanted even when six weeks old, but it is best to transplant them when 3 or 4 weeks old. Very frequently the young plants may be growing in the nursery whilst there is still a crop of paddy or ragi ripening on the rest of the land. Immediately that crop is reaped, the land is prepared and planted out with the seedlings. As the seedlings in the nursery occupy but a small space, they can be easily looked after, and as the nursery is very small, the quantity of water required for its tillage and irrigation is very small also: but it requires a good many labourers to transplant the seedlings.

Transplanting the seedlings.

The method of transplanting paddy is as follows:—A few men are employed in pulling up the seedlings by their roots from the soft soil of the nursery, and after the mud has been washed off the roots, the seedlings are tied into small bundles. These are carried by boys and girls to the fields and there the bundles are placed with their butt-ends in water, so that they may not wither. Women are usually employed in transplanting, and each takes a bundle in her hand, pulls out 3 or 4 seedlings and sticks them together in the soft soil. The seedlings thus planted should be 6 to 9 inches apart in all directions, but care should be taken that the roots of the seedlings are pressed well down in the mire.

Sowing paddy broadcast.

If the area to be planted is very large and a sufficient number of coolies cannot be hired at the time on fair wages, the whole of the land may be prepared and sown with paddy broadcast in the same manner as the nursery ground is sown, except that the seed is not sown so thickly. Those varieties of paddy

also which ripen in a very short time, for instance, the 60 days Samba paddy, should not be transplanted but sown. When paddy is sown on land which has been puddled, the water is kept on the land till the sowing is over and then drained off completely. The seed is always sown broadcast, and about 100lb., or four Madras maunds of seed are generally sown per acre. This is far more than is necessary, if good seed be carefully sown.

Treatment of growing paddy.

For about three days after the land is sown it is not irrigated, nor is the water changed if the land has been planted, but after that, it is watered every other day, and care is taken that the soil always remains wet till the crop bends down under the weight of the ears; that is, till about a fortnight before it is reaped. The water applied each time stands about 2 inches over the ground. A six months crop of paddy is watered altogether about 60 times during its growth. Therefore all the water applied to the soil, if not absorbed by it, would be about 60 × 2 or 120 inches deep over the soil. In other words, the total quantity of water applied to a six-months paddy crop is equal to 120 inches of rainfall. A paddy crop is weeded during its growth two or three times. The ryots reap the crop when the stems and blades turn yellow and the grain is quite dry. It might generally be reaped much earlier, *i.e.*, as soon as the grain has become hard.

Better systems of growing paddy.

Although the systems described above are the commonest, there are two others, which are followed in some parts of the Presidency which in some respects are much better. They may be called the Tinnevelly system and the dry sowing

system. In both of these the land is ploughed up in the first place in the dry state, just as has been described for dry cultivation and left exposed to the sun and air; a practice which is very beneficial. In Tinnevelly, the land thus ploughed breaks up in large clods, and is left for months exposed; it is then watered to soak and break down the clods, and then puddled and planted with paddy, or, when the clods have been broken down by exposure, it is sown broadcast. On the dry sowing system, the land is prepared in the same way as dry land and the seed paddy is usually sown with the drill in lines, and the crop whilst young is treated as a dry crop and not watered till it is about six weeks or two months old. The special advantage of the latter system is that the crop may be sown and grown to a fair size long before a supply of water has been received in the tank; whilst in both systems the soil is much benefited by thorough exposure to the air and by being kept under water for so much shorter a time.

The evils of the puddling system.

The present ordinary system of wet land tillage, which practically means the growth of paddy, may be improved. To understand this, it must be explained that the roots of paddy in this country are short and spread side-ways in all directions from the stems, penetrating the soil to but a slight depth, and the crop therefore requires the layer of soil in which its roots spread to be extremely fine and soft. It has already been shown that if soil be stirred well in water, and left, it will settle in layers, the lightest and finest particles forming the top layer. When land is puddled, the finest and softest particles of soil remain on the surface, and in this fine and soft upper layer the roots of paddy

spread, avoiding the coarser under-lying soil. The roots of paddy therefore penetrate the soil to a very slight depth, but they spread sideways in all directions. The plants therefore get nourishment chiefly from the thin fine upper layer of soil. Moreover, to protect the roots of paddy which lie so near the surface from the heat of the sun, the surface-soil must always be kept soaked in water, as the fine particles of the upper layer of soil remain loose and soft only so long as there is water in it; but if the soil is allowed to dry even for a short time, they draw together or contract into close cakes, so that the delicate roots of the crop are broken or injured, and thus the crop suffers. Besides this, in the puddling system, the soil is never thoroughly exposed to the air, and a very large quantity of water is used to grow the crop. Such are the evils of puddling wet land.

The Carolina system.

In America, where paddy is cultivated, land is prepared somewhat in the same manner as for a dry crop in this country. The land being deeply cultivated, the roots go down deep into the soil and consequently can endure several days' drying of the land. After the land is sown (the crop is not transplanted in that country as labour is very costly), it is watered for 4 or 5 days to make the seed sprout. It is then allowed to dry for a month and then again watered and the land remains under water for about a fortnight. After this it is not again watered for 4 or 5 weeks. During this interval, the land is hoed, which cannot be done on the puddling system. The land is watered after this until nearly harvest time. The land is allowed to be dry for a total period of more than two months, and the quantity of water applied to the land is equal

to about 48 inches of rainfall. In no part of India is wet land allowed to be dry for so long, or is so little water used for irrigating paddy. The paddy in America was originally obtained from India; but there, under the method of cultivation described above, its root growth has been altered and 'Carolina' paddy has become celebrated. If Carolina paddy be carefully cultivated, not only does the crop require much less water than the Indian sorts, but the water which is now wasted in the puddling may be saved also; for the land can be prepared for that crop with the aid of the moisture of the first rain of the cultivation season.

Manuring paddy.

Green plants, cattle dung, and other manures are seldom applied to the whole of the wet land. Paddy husk, which is a good manure for paddy and which is largely used by the Americans, is wasted in this country. The paddy crop in this country derives much of the matter required for its nourishment from the irrigation water, and it is partly for this reason that so much water is used. The irrigation water of tanks and river channels is generally more or less muddy, and when placed in a vessel for a time the mud is deposited at the bottom; this mud is called silt. The greater the quantity of water applied to the soil, the greater will be the quantity of silt which it receives. If land is properly manured, however, so much water as is now used will not be necessary. Again, it is far cheaper to grow a crop like horse-gram on wet land after harvesting paddy or before sowing the crop and to plough it under the soil than to purchase leaves of various kinds or to go to the expense of gathering them from distant places.

CHAPTER VIII.

Plant Nutrition and Manuring.

The substances of which plants are composed.

All cultivated plants grow on the soil and live by the matter they take into their structure either by their roots or by their leaves. These substances are of two classes. If any part of a plant be burnt, nearly the whole will disappear in smoke, and but a small quantity of ash be left, which will not disappear however long it may be exposed to fire. All that portion of the plant which passes away as smoke was originally derived from the air and is called organic, but that which is left as ash comes from the soil and is called inorganic. The air and the soil, then, are the sources from which plants obtain the matter of which they are made up. The matter which is required to nourish plants and becomes part and parcel of them is called plant-food.

Water.

Plants derive three substances from the air. With one of them, namely, water, everybody is familiar. The air supplies water chiefly in the shape of rain and dew, and it is from rain that the water of rivers, wells and tanks is derived. Without water, plants cannot grow at all; for not only is water in itself plant-food, but it is also required to dissolve most of the other substances which plants feed on, so that they may be taken into the plant by the roots.

Carbon.

Another important plant-food derived from the air is taken up by the plants chiefly through holes in the leaves, so small as not to be seen by the naked eye.

This is a substance called carbonic acid,* which exists mixed with the air, and, like it, is a thing which cannot be seen. The air which is breathed out by animals contains carbonic acid: plants in fact depend on animals for this sort of food. The black matter which appears when any vegetable matter is partly burnt and cooled, that is charcoal, is called carbon, and is derived from the carbonic acid taken up by plants through their leaves. Animal matter also contains carbon, which is derived from the vegetable substances which animals eat. Nearly half the weight of the plant in many cases consists of carbon. When carbon is burnt, it becomes carbonic acid and mixes with the surrounding air.

Ammonia.

Besides water and carbonic acid, the air supplies another substance to plants which is of such importance that, if it were altogether absent, the vegetable substances on which animals live would not contain the peculiar nourishing matter which is essential to the formation of flesh. This substance is also, like carbonic acid, invisible. It is called ammonia.†

* When fresh burnt lime is slaked in a large quantity of water, the lime gradually settles at the bottom and clear water collects above. Take a little of this clear lime water in a cup, and blow into it through a small tube (the hollow part of a quill, if cut, will do well). The clear lime water at once becomes milky, because the carbonic acid in the breath unites with the lime in the water.

† Mix some *Navacharam* with some fresh burned lime and pour water over the mixture. A peculiar kind of odour will be given off, and if a bit of saffron cloth be held above, it will turn brown. The gas, or substance which is the cause of the odour and which turns the saffron cloth brown is ammonia.

Ammonia is composed of two substances of which the one which is of value to plants is called nitrogen. This sub-

Although ammonia is derived from the air, it must first be stored in the soil, in order that it may be taken up by the roots of plants when dissolved in water. When rain falls, it washes out the ammonia in the air and takes it into the soil. In the hot and dry weather, there is more ammonia in the air than in cold weather. The early rains of the year, therefore, bring more ammonia to the soil than the later rains. Ammonia is very apt to escape into the air and must therefore be carefully preserved.

Water, carbonic acid and ammonia are the chief plant-foods supplied by the air. Ammonia is very valuable. In fact, it is the most precious of all the substances that plants need to nourish them; and it is very difficult to get enough of it for the requirements of plants. Water and carbonic acid, though extremely useful, are not so precious, because they are more plentiful.

The ash, or plant-food derived from the soil.

The ash which is left when a plant is burnt is obtained solely from the soil and consists of lime, sulphur, sand and iron, substances with which everybody is familiar, and also contains other substances which are not commonly known. Every-

stance is also supplied to plants in other forms, but ammonia is referred to as being typical and the most easily explained. One of these other forms is nitric acid (*Agni Dravakam*), which, though in a separate state useless to plants, when added to other substances is of great value to plants. Nitric acid, for instance, added to lime forms a substance called nitrate of lime. Saltpetre is composed of nitric acid and potash, and is called nitrate of potash. These substances, nitrates, and ammonia are those from which plants chiefly obtain nitrogen for their nourishment. Nitrogen in a pure state forms part of the air, and is an invisible substance, of no use by itself to plants.

body, however, has seen the red substance with which lucifer matches (நெருப்புக்குச்சி) are tipped. That substance is called phosphorus (பாஸ்கரம்). For the manufacture of lucifer matches, phosphorus is prepared from bones; it is thus clear that bones contain phosphorus: almost every other part of an animal contains some phosphorus also. Animals derive phosphorus from the vegetable substances on which they live, and the plants derive it from the soil. Next to ammonia, this is the most precious of plant-foods, whilst next below it in value a substance called potash is most esteemed. That substance is contained in saltpetre and in the ashes of land plants.

A substance called soda is largely consumed by plants, but it is not of much value on account of its abundance: the flame of a fire or of a lamp is yellow because there is soda in the wood, or in the wick or the oil; otherwise the flames would be colorless: it is found much more abundantly in sea than in land plants. These three substances, phosphorus, potash and soda, are not very commonly known, but the two first named are extremely valuable to all crops. There is also more or less lime in all plants, but this substance is mostly required by pulse crops and is tolerably abundant in most soils. Sand, also called *silica*, is found in large quantities in the hard and smooth outer portion of the bamboo, and in the straw of cholum and other grain crops. Onions, garlic, mustard, cabbages, radishes, &c., contain a good deal of sulphur, and to it they owe their peculiar odors. If the soil supplied no iron to plants, they would not be green, and could not grow properly; but a very small quantity of iron is enough.

There are other kinds of plant-food supplied by the soil, but they need not be named here. Each and all of the substances mentioned above are necessary for the proper nourishment of plants, although soda and sand are not of much importance.

The preservation of fertility.

If a number of plants grow on a piece of land they each remove from it various kinds of plant-food for their nourishment. If these plants are not removed from the land, they die sooner or later and their remains are added to the soil, and whatever plant-food had previously been taken by them from the soil is returned to it. In fact, the soil derives from the decayed plants something more than what it supplied for their nourishment; for more than three-fourths of the substance of the plant being derived from the air, nearly all that matter is added to the soil. Again, if a crop growing on a piece of land is grazed down by sheep folded on it, then whatever substances have been removed from the land by the crop for its nourishment are eventually returned to it by the sheep, in the shape of dung and urine. There is thus no loss of plant-food to the soil, but on the other hand, the organic matter, derived from the air by the crop and contained in the dung and urine, is so much gain to the soil.

The exhaustion of fertility.

If the crop raised on a piece of land be removed from it, then the substances taken from the soil by the crop for its nourishment are lost to the soil, and if the land is not rich in these sorts of plant-food, its productive power will decrease even after only one or two crops have been taken away in that manner. This is why the hill

tribes in some places abandon the land they cultivate in one year and take up a fresh piece in the next. If crop after crop be grown and removed, the store of plant-food in the soil is eventually so much diminished that the soil becomes unable to produce profitable crops. The soil is then said to be *exhausted*. Exhaustion does not necessarily mean that the store of every kind of plant-food is seriously diminished; for, even if any one kind, say, lime, be very much reduced, however rich the soil may be in other kinds of plant-food, it will be unfit for the profitable cultivation of any crop which needs a large amount of lime. Exhausted land does not necessarily remain for ever exhausted, but usually gradually recovers; for the plant-food in the soil exists in two states, viz.;—

(1) in an active condition; that is, in a condition fit for the immediate use of plants;

(2) in a passive, dormant, or inert condition; that is, in a state not fit for the immediate nourishment of plants;

And an exhausted soil, if it be allowed rest, in the course of years again becomes fit for profitable cultivation by the passive plant-food in it becoming active.

The preservation of fertility.

The ryots know that rest renovates the soil, and often leave large areas waste for several years together to allow them rest. They also know that certain crops, such as gingelly and other oil-seed crops, sugar-cane, &c., are far more exhausting than others, and do not grow them annually on the same land. It is no matter for wonder that these crops are so, for they remove a comparatively large quantity of various kinds of plant-food from the soil: the stems and leaves of the plants are removed and burnt, and the ashes thrown away, and the produce is sold, or if

the produce be consumed by the ryots' cattle, their dung and urine, which contain the substances removed from the soil, are only in part returned to the soil. Under proper management, however, none of the crops above referred to should be exhaustive; for the products, viz., oil, cotton, sugar, &c., contain but little of the more precious plant-foods, and they alone should be sold, while all the other parts of the crops may be returned to the soil either directly, or in some cases in the shape of dung and urine after having been used as food for cattle.

The objects of manuring.

Sometimes, however, the ryot is obliged to sell the oil-seeds, the cotton-in-seed, that is cotton from which seed is not separated, or the sugarcane crop itself. Then he should take care to return to the soil some substance which will supply to it whatever plant-food has been removed in the products he sells. Generally speaking, if crop-produce containing much of the matter removed from the soil by plants is sold, the loss of plant-food to the soil in that way should be made good by the application of manure. A manure is a substance which, if applied to the soil, increases its productive power either by increasing the store of plant-food in it; by making active some of the passive plant-food; or by improving the condition of the land, such as making a stiff soil more free and open or a porous soil stiffer.

CHAPTER IX.

Manures. The management and use of Farm-manure and other common manural substances.

The classification of manures.

Manures are classed as either general or special. A general manure is a manur which supplies to the soil a the substances required f the nourishment of crops; for instance, cattle dun is a general manure. A special manure is one which supplies only one or two of the substances particularly required for the nourishment of particular crops, or by a particular soil; for instance lime is a special manure for ground-nuts and certain other crops. Manures are also divided into three classes, viz., animal manures, vegetable manures, and mineral manures, according to the sources from which they are obtained. Animal and vegetable manures yield on rotting a brownish black substance called *humus*, which is very useful in this country for making the soil absorptive and retentive of water: they also supply the soil with the matters contained in the ash of plants. As a rule mineral manures only supply one or more of the substances found in the ash of plants. The chief animal manures are farm-manure, slaughter-house refuse, hides, hoofs, horns, hair, night soil, the carcases of animals, bones, &c. The chief vegetable manures are oil-cakes of sorts and green manure. The chief mineral manures are tank mud, ashes of various kinds, saltpetre, salt, lime, &c.

Farm-manure consists of the dung and urine of the animals kept by the farmer, together with the vegetable rubbish supplied to the animals for bedding.

The general mismanagement farm-manure.

In this country, however, cattle are almost the only animals kept by most farmers; the urine of cattle is seldom preserved as manure, and very rarely is bedding supplied to the cattle. The dung also is too frequently wastefully mismanaged. It s often made into bratties, and burned as fuel, which is very unwise; for the ammonia, which is the most precious of all sorts of plant-food, goes off with the smoke and is lost. Then the ashes are generally thrown out in the open, and some of them are lost by being blown away by the wind; and, when rain falls upon them, the water either flows away or sinks through the ash-heap into the ground, carrying with it much of the valuable plant-food contained in them. The water draining from a heap of ashes may be perfectly clear, but still it may contain much plant-food dissolved in it, as has already been seen in the case of lime-water, which may be perfectly clear, and nobody be able to see the lime dissolved in it. Sometimes the ryot does not burn the dung, but throws it in a loose heap in the open air near his house. In this case also a good deal of the ammonia goes off, owing to the heat of the sun and to the rapid fermentation of the manure, and the other kinds of plant-food are to a great extent washed away by rain; but the loss of manure is not so great in this case as when the dung is burned.

The ryot, it is said, burns cattle dung as fuel, because he is too poor to buy firewood; but, supposing he owns a pair of cattle, if he collects their dung for a whole year and makes

it into bratties, it will not make more than 3,000, which are not worth more than about Rs. 6 even in places where they are dear. By using cattle dung as fuel, the ryot makes only a very petty saving of expenditure, and the dung and the urine of a pair of cattle, if properly managed, will be worth at least about Rs. 15 as manure. Moreover, by growing hedges around his land, a ryot can get a far better supply of fuel from the hedge-cuttings than by making the cattle dung into bratties.

A good system of management.

An excellent method of managing farm-manure suited to the conditions of the ryot is described below. In this method the dung and the urine are not removed from the shed except at intervals of several months, when the manure is required. The litter used absorbs the urine.

The floor of the cattle shed should be made two or three feet lower than the surrounding ground, and the sides and the bottom of the pit plastered with clay. On the floor a layer of ashes should then be spread once for all, and every day a layer of vegetable rubbish should be spread over the surface as litter, that is, bedding. For this purpose, leaves, coarse grass and other vegetable rubbish may be collected and stored during those parts of the year when the ryot and his cattle have plenty of leisure. Waste fodder and various refuse portions of crops, such as the ear-heads from which corn has been thrashed, &c., may be used as bedding. The shed may be 10 feet long and 6 feet broad for a pair of cattle. The cattle should be left loose in the shed, so that they may tread on every part of the manure and press it down. If the manure is not pressed, it will rot too fast, and become much heated, and give off bad smells, and the health of the cattle will be injured. Every morning the dung dropped by the cattle in the previous night should be evenly distributed, and a thin layer of litter spread over it. In this manner the manure may be collected until the pit is filled, which takes about three months. Too much bedding should not be supplied; otherwise the manure will be inferior and decay too rapidly. If the manure has an ash-colored appearance anywhere when it is being removed, that is a sign that it is so decaying, and is due to the

great heat caused by the manure being too dry. If the straw, &c., supplied as bedding be long and hard, the manure will not rot properly ; such litter should be cut up into short pieces. Unless the manure is well rotted, it will not be of much use to crops, as it will not act quickly. The manure, if properly managed, will be of a black color, soft, and rich looking. In removing manure from the pit, the unrotted portion near the surface should be placed on one side, and after the well-rotted portion has been taken out, should be put back again at the bottom of the pit, and manure may be collected again as before.

By this method of managing manure, about 5 to 7 tons of good manure may be obtained yearly for each head of cattle kept, whereas if the dung be thrown out in loose heaps in the open air, only about half a ton of very inferior manure will be obtained in the year. The only objections raised to the system are :—

(1) That it is supposed to cause unhealthiness amongst the cattle housed.

(2) That it requires a large amount of litter to be supplied.

In reference to the last, it may be noted that in some parts of South Canara the ryots take great pains to collect leaves and grass, and supply bedding to their cattle; but they remove the manure at intervals of a few days, and throw it out in a hollow place where it can be compressed by the carts travelling to and fro over it. In reference to the first objection, experience has shown that it is groundless.

Another good system.

If for any reason it is inconvenient to a ryot to collect manure in the above-mentioned manner, the following method may be adopted :—

The floor of the cattle shed should be made smooth and compact with a gentle slope towards one side, where a small channel should be placed, so that all the urine falling on the floor may be carried by the channel to a pot placed outside the shed at one

end. The dung can be removed every day and thrown into a pit, the sides and bottom of which should be plastered with clay, and over which a low thatched roof has been erected. Whatever vegetable refuse is available on the farm may be thrown into the pit, and the urine collected poured over the heap daily. The whole mass of dung, urine and vegetable rubbish should be kept uniformly mixed and well trodden and pressed down so as to make the mass decay uniformly and slowly.

The quality and application of manure.

The manure obtained from full grown animals is better than that obtained from young animals, and that obtained from a pregnant or a milking cow is inferior to the manure obtained from a cow which is not in that condition. Farm-manure should be spread over the land uniformly and ploughed in. If it be left exposed to the air, a large amount of ammonia will be lost. If the land is ridged, the manure may be put in the furrows, and then, by splitting the ridges with a plough, where there were furrows before ridges will be formed with the manure buried under them, and then if a crop be sown or planted on the ridges, their roots will find a supply of food easily, and be induced to strike deeply. For stiff land, unrotted farm manure is preferable. For a sandy soil well rotted farm manure is good.

Sheep-folding and other farm manures.

Sheep are generally folded on the land to manure it, and by this method the urine is made use of. Sheep dung acts more quickly than cattle dung. The number of sheep required to manure one acre of land fairly in one night is 2,000, but usually smaller flocks are used and are kept for several days on that area. Horse dung is a very valuable and also a quick acting manure; it should not be kept long, as it decays very fast, and should

therefore be applied to the land without delay. The dung of fowls and other birds is available only in small quantities, but it is the best of all manures obtained from living animals. It should be mixed with a large quantity of earth or ashes, and then applied to the land.

The refuse from slaughtered animals.

Sheep and cattle are slaughtered in large numbers in many places for mutton and beef. A large quantity of blood is available in such places,—a little of it is taken by men for food, but almost the whole is at present wasted. It is one of the best manures that can be got. To utilize it, a pit should be dug and the sides and the bottom of it plastered with clay; the blood can then be put into the pit and mixed with ashes and vegetable rubbish, and this continued till the pit is full. Blood manure may be applied with advantage to sugarcane and other valuable crops.

Other animal refuse.

Old hides, hoofs, horns, hair, woollen rags, &c., are good manures, but they are not generally available in large quantities. In sacred places, such as Tirupatti and Allahabad, where numerous pilgrims get shaved every day, a large quantity of hair may be daily collected; but all this is now wasted, its value as manure not being known. If a dead animal be buried with plenty of lime, the carcase will, in the course of about a year, make an excellent manure. In places where silk-worms are reared, a large quantity of the worms, which are killed inside the cocoons by being put in boiling water, is available. These form a very good manure, but it is not now used by the ryots.

All the manures of animal origin hitherto spoken of are chiefly valuable on account of the large quan-

tity of ammonia which they supply. They must all be ploughed into and mixed with the soil, otherwise the ammonia will escape.

Night-soil.

In China and Japan, human excrements are never wasted, but are very carefully preserved and used as manure with good results. These matters are likewise used by many ryots in Mysore and in certain villages near Madras and elsewhere as manure. They may be collected in pits in the same way as blood manure, plenty of ashes and vegetable rubbish being added, and kept for a few months before use. Human urine is available at the latrines attached to the railway stations. Ryots having land close to the stations may with advantage use it as manure, after mixing with it ashes and other stuff to remove the bad smell.

Bones as manure.

There is another manure derived from animals, namely bones, which are valuable chiefly on account of the large quantity of phosphorus which they supply to plants. The coffee planters use bone-manure extensively. Bones act very slowly even when broken up into small pieces, but to make them act more quickly they may be treated as follows:—

Break the bones to as small pieces as possible; mix them with cattle dung or some oil-cake; pour water over the mixture, and keep it moist; when a bad smell begins to be given off, cover the mixture with earth, and in a little time the bones will be softened and may be applied to the land.

At Nellikuppum in South Arcot, and at other places, charcoal is made out of bones and is used in purifying sugar. The bone-charcoal which has been used thus is a valuable manure, but it acts very slowly on account of the carbon and the sugar which it contains, as these both prevent decay.

Fish manure.

Fish is another valuable animal manure which supplies plenty of phosphorus besides other plant-food. The bad smell of decaying fish is caused by the phosphorus existing in them. In Malabar and some other sea-coast places, fish refuse is used as manure. It is particularly valuable for cereals, grapes and fruit trees.

Oil-cakes and their use.

Oil-cakes are the most fertilizing of vegetable manures. The chief oil-cakes are castor cake, ground-nut cake, gingelly cake, bassia-nut cake, and cocoanut cake, which are mentioned in the order of their value as manures. Castor cake and bassia-nut cake are only fit to be used as manure: the other oil-cakes form nutritious foods for cattle, and it is unwise to use any of them as manure directly to the soil. The soil will be better fertilized if the dung and urine of cattle fed on these oil-cakes be carefully preserved and applied. In the North and South Arcot districts ground-nut cake is applied to the soil directly, and so also is cocoanut cake in some parts of Malabar. As a rule, the smaller the quantity of oil left in an oil-cake, the better it is for manure; for it will then rot properly and act quickly. Any oil-cake, if very old and mouldy, may be applied to the soil at once Before applying an oil-cake to the soil it should be broken to powder or into small pieces, and may then be broad-casted over the land evenly at the rate of about 500 to 1,000 lb. per acre, and harrowed in. An oil-cake in fine pieces or powder may be applied as a top-dressing; that is, it may be applied on the surface of the soil whilst a crop is growing; but usually it is best to apply it to the land before sowing the crop.

It has already been said that green-manure, con-

sisting of the leaves of various kinds of plants, is applied to wet land. Occasionally indigo is ploughed in by the ryots as a manure for paddy. Green manure is beneficial to all sorts of land, whether wet or dry; for it enriches the soil with *humus*, and helps to make the inert plant-food in the soil active. A good system of green manuring is to grow a crop of horse-gram on the land to be manured and to plough it in.

Green manuring.

The crop is hardy and does not require much moisture; it may be sown at any time when there is just moisture enough in the soil for purposes of tillage and the germination of seed. Wet land, as soon as paddy has been harvested and whilst the land is still moist, may be ploughed, harrowed, and sown with horse gram. The crop will grow fairly, even if there be but little rain during its growth. If the crop be sown in January, when paddy is so often harvested, it will grow remarkably well, for it benefits by the heavy falls of dew. Dry land may likewise be prepared and sown with horse gram. In about 2½ months from the date of sowing, when the crop begins to flower, it may be ploughed in.

The cost of producing a crop of horse gram for green-manure is not more than about Rs. 2 per acre.

The mineral manures used by ryots are chiefly the ashes of various kinds, and tank-mud. The ashes from the house-hold, potter's ashes, the ashes from brick-kilns, and paddy-husk ashes are all useful, as supplying potash chiefly, but the latter supply a good deal of phosphorus also. The ashes of sugar-cane refuse are very rich in plant food, but the ryots do not use them as manure, saying that they injure the soil. Leaves and the tender and juicy portions of plants give more ashes on being burned than wood. In making jaggery from palm juice, the palm leaves are used as fuel; the ashes are especially rich in potash. To the brinjal crop

Mineral manures—ashes.

ashes are particularly applied, for it requires plenty of potash. The ryots generally store ashes in the open, and then much of the plant-food contained in them is washed away by the rain. Ashes should be applied to the soil when it is fairly moist; if they are applied when the soil is dry, they will be blown away by the wind.

Tank mud, if available at a convenient distance, may be used for improving sandy and other inferior soils.

Saltpetre.

Saltpetre contains two sorts of plant-food, of which one is potash and the other is a substance which is known in the vernaculars as *agni-dravakum*,* which may be seen in hospitals. A manure containing this substance if applied to a crop makes its growth very vigorous. Saltpetre is specially useful to tobacco, brinjals, chillies, potatoes, and other crops which require plenty of potash. Impure saltpetre, which is quite good enough for manuring purposes, is available in many parts of the Presidency, such as Coimbatore, Trichinopoly, Salem, &c., at about Rs. 16 per candy (500 lb.). Of course, pure saltpetre fit for making gunpowder is sold at a much higher rate, but pure saltpetre is not wanted as manure. Saltpetre may be applied at the rate of about 100 lb. per acre, but it is well to mix it with soil or ashes and then to broadcast it over the surface of the land when the crop is young and growing. To wheat, saltpetre may be applied with good effect mixed with common salt in the proportion of 100 lb. of saltpetre to 200 lb. of salt per acre. If a cereal crop is pale and not doing well, a dose of saltpetre will in many cases make it all right. Saltpetre has the property of

* The English name for *agni-dravakum* is nitric acid; see note, page 62, chap. VIII.

absorbing moisture from the air; it should, therefore, be preserved carefully and the air excluded before it is applied to the soil.

Lime.

Lime is a very important mineral manure, the use of which is unknown in this country. It is, however, not altogether unused; for the refuse of tanneries, consisting of a mixture of hair and lime, is applied with very good effect to land by the ryots in many places. Lime is not only a plant-food in itself, but it also makes much of the inert plant-food in the soil active, and thus increases the productive powers of the land; but it very soon causes exhaustion of the land, and its use may thus prove a great evil if crop after crop be removed without any return, except lime, of what is taken from it be made to the land, though for a time the cultivator may be a gainer, by obtaining a very good outturn from his land. A very good crop means, of course, the removal from the soil of a very large quantity of plant food, and therefore when lime is applied alone without any manure to replace the loss of other kinds of plant food, the land becomes exhausted in a short time. This circumstance has given rise to the proverb, " Lime enriches the father and impoverishes the son." Lime is especially useful to pulse crops and other crops similar to them. To plantains, sugarcane, ground-nuts, indigo, &c., lime is also very beneficial. The proper method of applying lime is as follows:—

Slake the burnt lime to powder with a suitable quantity of water or by mixing it with a sufficient quantity of moist earth or rubbish, and expose it to the air for some days. If the soil to which it is to be applied be stiff, it need not be exposed for long. Spread the lime on the surface of the land broadcast before the crop is sown or planted. From 500 to 1,000 Madras measures of slaked lime may be applied per acre. The cost of slaked lime is about Rs. 3/8 for 500 measures.

Common salt.

Common salt is often applied to young cocoanut trees as a manure; it may also be applied to ragi. In places far away from the sea, it is particularly useful. Soils at no great distance from the sea-coast get a supply of salt from the air, as the breezes carry part of the salt-spray to them. Mixed with saltpetre it is good manure for wheat.

In applying any manure to land, special care must be taken that it is evenly distributed; otherwise the effect on the crop will not be uniform.

CHAPTER X.

The supply of water and Irrigation.

Means of supplying water.

The rain water that falls on the surface of the land either flows away from it without doing any good where it falls, or sinks into the soil. That portion which flows off the surface is gathered into rivers and flows away to the sea, or is collected in tanks for future use. The water flowing in a river towards the sea may be cut off by throwing a dam across it, and used for filling tanks, or for irrigation direct. The portion which sinks into the soil in part sinks so deeply into it as to be useless to plants growing thereon, and goes down as far as it can until it meets with a bed of rock or clay. This part may be made useful again by digging wells. Almost everywhere water may be found at a greater or less depth by digging a well, whereas tanks and river channels can only be constructed in comparatively few places. Wells, as a rule, do not dry up in dry weather so soon as rivers and tanks; thus, as wells will supply the needful water, crops need not fail in long droughts, and famine may, to a great extent, be prevented by an abundance of wells.

The preservation of water in the soil.

The artificial supply of water to crops from rivers, tanks, and wells is called irrigation. If the natural supply of water in the form of rain be as fully used as possible, the irrigation, which is costly and laborious, will not be so much required. Water is taken up by plants chiefly through their roots, and the roots live in the soil. The deeper

the roots go into the soil, the better they are protected from the heat of the sun. To use irrigation water with the utmost economy the soil should be made as absorptive and retentive of moisture as possible, and plants should be induced to strike their roots deeply into it. The means of making the soil absorptive and retentive of moisture are :—

(1) Deep and thorough tillage;

(2) Making the soil sufficiently stiff, if it is too porous, and sufficiently porous if it is too stiff; and

(3) Enriching the soil with *humus* or vegetable mould.

The benefits of tillage.

The water supplied by rain or by irrigation to uncultivated or shallow cultivated land is quickly lost; for it either flows over the surface, and runs away, or if it stagnates thereon, evaporates. If the soil is neither too porous nor too stiff and is well tilled, it absorbs most of the water, and though part of this may sink deeply into the soil, some of it will, when the soil begins to dry up at the surface, be gradually raised again and thus become available to plants. It has already been said that paddy fields in America are kept dry for long periods, and that during there periods the land is hoed. The paddy crops grown there are not without a supply of moisture during these periods; for the soil being moderately loose and dry at the surface, that portion of the water previously applied to the crop which has sunk down into the soil rises again gradually to the surface, and refreshes the crop. But, in this country, wet land is made close and stiff at the surface, as already explained by being puddled, and the surface is never allowed to dry during the growth of the crop;

the soil becomes full of water, and the part which sinks far down is for the most part lost to the crop. Frequent watering causes the finer particles of the soil to collect at the surface, and if this dries, the particles become so closely connected together that it becomes very hard. This is undesirable, for the air then cannot freely enter the soil ; any rain which falls on the surface flows off ; and, above all, the water in the deeper layers of the soil will not rise to the surface.

The value of humus.

Humus or vegetable mould has the property of taking up moisture from the air and of absorbing and retaining a very large amount of water. A soil when enriched with *humus* is thus made absorptive and retentive. It is therefore advisable to add in every possible way to the amount of vegetable mould in a soil, in order to preserve in it the rain or irrigation water it receives. In hot dry weather rotten vegetable matter, if applied on the surface of land, not only preserves the moisture of the soil from evaporation, but also absorbs dew from the air at night. The application of such matter on the surface is called "mulching." This process is specially beneficial to newly-planted young trees.

The advantages of deep roots.

Trees, such as the mango, the banyan, &c., do not fade in dry weather which may be severe enough to cause the withering of field crops. The reason for this is that the roots of these trees run very deeply into the soil, and their delicate ends, being far removed from the surface of the soil, are protected from the heat of the sun. Moreover, the deeper parts of a soil, as a rule, contain more moisture than the upper parts. Of field crops, cotton, the castor crop, and other deep rooted crops withstand dry weather much better than

others having shallow roots. By deep cultivation, and by applying water and manure in such a manner that the roots may obtain food and drink for the plants from below, the roots are induced to strike deeply.

Precautions in irrigating.

All the irrigation water which fails to sink into the soil goes to waste; for it is not accessible to the roots of plants, and gradually evaporates or runs away. Water should, therefore, be passed through the soil, and not simply over it. The water applied to the soil should never be allowed to become quite still, but should be slowly but constantly moving amongst the particles of the soil. Stagnant water almost wholly prevents air from entering the soil, and a soil cannot be healthy unless many of the spaces between its particles contain air. Stagnant water evaporates and thereby makes the land cold. No field plants can grow in a healthy way unless the soil is sufficiently warm.

Irrigation, like lime as a manure, will exhaust the soil rapidly if what is taken from it be not returned in the shape of manure; for irrigation increases the productiveness of the soil, and an increase of produce means, of course, an increased removal of plant-food from the soil. It is often the case, however, that wet land is not exhausted by the successive removal of a number of paddy crops raised without any manure. This is because the irrigation water from tanks and channels, as a rule, brings with it more or less silt. If paddy crops be grown without manure under irrigation from wells, the land will in a short time become exhausted; for there is but little in well water to make up for the loss of plant-food caused by the successive removal of crops grown without manure.

Water-lifts.

Irrigation from wells is also very costly and laborious, as the water has to be lifted. Any contrivance by which water is lifted for irrigation is called a water-lift. The water-lifts commonly used in this country are the picottah and the single *mhote.* These machines are so well known as not to need a description. In the picottah the lever turns on an axle, which is generally made of wood, but it will work more easily if the axle be made of iron, and if the rests on which the axle turns be lined with iron also. Usually also one, two or three men walk up and down the lever, and another standing over the well guides the bamboo pole to which the bucket is attached. By carefully arranging the balance on the lever, one man can do all this work, and no one need walk on the lever. The picottah is an excellent water-lift, if the height to which water is to be lifted does not exceed 12 feet.

From a well 12 feet deep an ordinary picottah, worked by 3 men, will lift about 4 buckets per minute, each bucket holding about 6 gallons of water, and it thus takes these men about 2 days to water an acre of ground with one inch of water over the whole surface.

The single mhote is usually worked by a pair of cattle and a driver, but in some districts more than one pair is used, by which means the very trying work usually put upon the cattle in backing them up the slope is avoided; one pair walking quietly up, whilst the other is pulling down the slope to raise the bucket from the well. For lifts exceeding 15 feet, the single mhote is well adapted.

From a well 20 feet deep, a bucket holding about 30 gallons of water is raised in a minute. So, in a day of 9 working hours, this water-lift raises about 16,200 gallons 20 feet high; at this rate it would take a day and a half to water an acre of land.

The double mhote, which has not yet come into general use, is so called, because it raises water by two buckets alternately, one bucket going down into the well, while the other is coming up filled with water. It is worked by only one bullock walking round and round a drum on which the ropes are coiled. As soon as a bucket is raised, the bullock turns about and walks round in the opposite direction till the other bucket is raised, and then reverses again and so on. This water-lift raises somewhat more water than the single mhote, and requires only one bullock, whereas the single mhote requires two. It is, however, much more costly to erect.

When water is only one or two feet below the level to which it is to be raised, it is lifted by means of a sort of basket slung by 2 ropes held by 2 men, called a "bale." Under such circumstances water is also lifted by means of a big wooden spoon (Tam. *oni*) suspended from a tripod.

CHAPTER XI.

The Seed:—Selection, preservation, and preparation for Sowing.

The selection of seed.

To produce a satisfactory crop, good seed is necessary. Seed should be ripe, fresh, plump, and sound. Seed should be ripe, in order that the germ may be fully formed; otherwise it will not sprout. The germ or embryo is an exceedingly minute plant consisting of root, stem, and leaf, somewhat similar to a child in the mother's womb. It may be distinctly seen with the naked eye in many of the larger seeds, such as tamarind, castor seed, dhál, &c. At first, the germ is nourished by the matter of the seed in which it is enclosed. If a seed is kept moist enough and warm, the germ sprouts and grows at the expense of the seed matter. As long as the germ is not dead in the seed, the seed is said to be vital.* The larger the proportion of vital seed, the smaller is the quantity of seed required for sowing. As seed gets old, the germ gradually becomes weak

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* It is very important to ascertain what proportion of seed grain is vital; for seed which is apparently very good often proves to have lost its vital power, and if such seed be sown without being tested, the labor of sowing will be wasted, and the land will have to be prepared for sowing again, perhaps after the proper season has passed. The method of testing the vitality of seed is as follows:—Take a dish and fill it in with fine soil or sand: scatter 100 seeds on this and cover th seeds lightly by dusting more soil over it: keep the soil moi and count all the sprouts as they appear. If the numb seeds which sprout be less than 50, and they appear the seed is unsatisfactory, and it is, as a rule sow it.

and eventually dies. The seed obtained at the previous harvest should, as a rule, be selected to be sown in due season; in fact seed should not in most cases be more than a year old.

Seed should be large of its kind; for a large plump seed means, of course, a good store of nourishment for the germ, and it must be borne in mind that plants as well as animals cannot thrive well unless they are properly nourished when very young. A plump seed is one which is well filled and not shrivelled. Seed is said to be sound if it be healthy and free from holes, cracks or other injury, such as those caused by insects, &c. Most seeds, if sound, sink when put into cold water—and more freely in warm water—so that their soundness may be tested by putting them in water and observing what proportion of them float.

Trueness of seed.

The seed to be sown should also be true to its kind. For instance, if it is intended to sow Carolina paddy, care should be taken that no indigenous paddy is mixed with it. There is no certainty that a given sample of seed will produce a crop as good as that from which it has been obtained, other conditions being equal; but if a careful selection* of seed be made, the seed so obtained will in all probability produce its like.

*The method of selection is as follows:—Suppose for instance that it is desired to make a selection of seed-cholum: a crop of cholum should be cultivated as well as possible; the largest ears which ripen early and which contain the largest number of plump grains gathered; these should be threshed separately and the best grain selected for sowing. From the crop produced from such seed again under careful cultivation, selection should be made in the same manner as before, d the process repeated several times. Eventually the seed ed after several such selections will be found to have of producing a good crop of its kind with great

A crop produced from such seed will yield heavily and ripen uniformly, which is a great advantage, for a crop which does not ripen uniformly cannot be reaped without some part of it being injured by being either unripe or over-ripe. But if the seed obtained by selection be sown in the same soil again and again, its vigour will diminish. It is therefore well to have a change of seed. For instance the seed obtained by repeated selection from a sandy soil may after a few years be transferred with advantage to a clay soil, and *vice versâ.*

Preservation of seed.

Seed should be carefully preserved till it is wanted for sowing. It should, above all, be thoroughly dried in the sun; for moist seed often sprouts or gets heated, and the germ is thereby killed. The dried seed should be placed in a pot with a closely fitted lid and some ashes should be put over the lid to prevent insects from getting in. It is also well to put pieces of camphor or small cups of turpentine on the seed in the pot, so as to keep off insects which abhor the odour of these substances.

The preparation of seed for sowing.

Seeds, such as cotton, which have a fibrous covering should be rubbed with moist earth or cow-dung before being sown, for otherwise they will stick together and not fall separately as is desirable. If it is intended to sow seed very sparingly, and if this cannot be done by broadcasting or by the drill, the seed may be mixed with sand or earth and then sown. This may often be done with very small seeds, such as indigo or ragi. Seeds such as maize, which are very much liked by crows, squirrels, rats, &c., should be tarred so that they may not be picked up by the vermin.

The manner of tarring maize and other similar seeds is as follows:—For 50 lb. of seed take a mixture of ¼ ollock of tar and half a Madras measure of hot water. Mix the liquid thoroughly with the seed, and then mix some sand or dust with the dressed seed, so as to keep the grains separate.

Plant diseases.

Plants, like animals, are subject to diseases. Most of the diseases of plants are due to parasites, which are extremely minute plants that cannot be seen by the naked eye, but are nourished at the expense of the bigger plants which thereby suffer. For instance, a cholum crop when ripening is often attacked with a disease called smut. The seeds of cholum then become lengthened and tapering with a white covering, and when pinched are found to contain a black powder somewhat resembling snuff. Each particle of this powder is a seed which will produce a parasite, and thus the disease will spread, as the particles or germs of smut often adhere to sound seed, and the crop produced from such seed may be again attacked by the disease. As it is impossible to say whether a given seed contains the germs of disease, it is a good plan to mix all seed, before sowing, with something that will kill germs, if any, without killing the germ of the seed itself. Blue vitriol is a very valuable substance for the purpose.

The manner of dressing seed with blue vitriol is as follows. For 200 lb. or 8 Madras maunds of seed take about 30 rupees' weight of blue vitriol, and dissolve it in 33 Madras measures of hot water. When the liquid is cool, sprinkle it over the seed, spread about 6 inches deep on a hard floor, stirring the seed at the same time so as to mix it with the liquid thoroughly, and then let it dry before sowing. As blue vitriol is poisonous, seed dressed with it should not be eaten. If too much of the dressing is used, it will kill the seed.

CHAPTER XII.

Fallowing and Rotations.

The objects of fallowing.

Sometimes, when a ryot finds that the productiveness of his land after the continuous cultivation of crops without sufficient manure is much diminished, he either abandons it entirely, or stops growing crops on it for some years. If rest be thus given to the soil for a time, part of the inert plant food in the soil becomes active, even though the land be never tilled. This is caused by the action of the air found in the soil, and it is therefore clear that, if the soil were well tilled during this rest, a much larger proportion of the inert plant food would be made active, as the soil would then be more fully exposed to the air. The practice of tilling the land and leaving it exposed whilst it is being given a rest from cropping is called fallowing. Thus, strictly speaking, the ryot's practice of occasionally leaving the land uncropped and untilled is not fallowing. If land be tilled and a crop be grown on it, either to be ploughed in as green-manure, or used as a restorative crop and fed off by sheep or other stock, it is said to be green-fallowed; but if it be simply tilled and left exposed, it is said to be bare-fallowed. Bare fallowing is especially useful for cleaning foul land.

Generally, when a wet crop is harvested, there is a fair amount of moisture in the soil, which will admit of the land being green-fallowed, or at least bare-fallowed. When most of the dry crops are harvested, there is also a fair amount of mois-

ture in many soils, and these may likewise be fallowed, if no time be lost in ploughing the land after the harvest. Thus even between one harvest and another a field may be fallowed for a brief space.

The objects of a change of crop.

Some kinds of crops demand large supplies of particular kinds of plant-food from the soil. For instance, the grain crops require nitrogen and phosphorus, whereas the pulse crops require lime chiefly. If a grain crop be cultivated year after year on the same soil, the available supply of nitrogen and phosphorus in it will be exhausted. On the other hand, if a grain crop be alternated with a pulse crop, a comparatively small amount of these matters will be taken from the soil, and that portion of them which is in an inert state is rendered active during the same time, so that what has been removed by one grain crop may be made good before another is grown. For this reason crops which feed on any particular kind of plant-food should be followed by others feeding on other kinds.

Some crops, such as indigo, cotton, &c., have deep roots which remove plant-food chiefly from the lower layers of the soil, whereas others, such as ragi, spread their roots in the surface soil and are chiefly fed from the surface soil. If surface-soil feeders and sub-soil feeders be grown alternately, the sub-soil and the surface soil will have rest alternately.

Some crops again are liable to the attacks of particular kinds of insects, which always feed on them. The cultivation of such crops year after year on the same land gives an unfailing supply of food to these insects, and they will thus multiply rapidly. On the other hand, if such a crop be followed by another which supplies no food for these insects, they will die out for want of their proper food.

Some plants, like cotton, grow in such a manner as to encourage the growth of weeds, whereas others, like horse-gram, which cover the ground well, keep the weeds down. If a crop of the former kind be grown year after year on the same soil, the land will become foul, unless very great care is taken and much expense be incurred to clean it.

Again, some crops, like tobacco, wheat, &c., remove from the soil a comparatively large quantity of certain kinds of plant-food, and their produce is consumed in such a manner as to make it difficult to restore to the soil what has been taken from it. Such exhaustive crops should not follow each other on the same soil frequently. A crop, the produce of which is consumed in a manner that makes it easy to return to the soil what has been taken away, is called a restorative crop. A fodder crop, for instance, is a restorative crop. It is desirable that an exhaustive crop should be followed by a restorative crop.

Rotations.

Suitable changes of crop in succession are called 'Rotations.' A rotation of crops is advantageous because it affords the land rest, but it is not a necessity; for there is no harm in growing any crop whatsoever again and again on the same land, if enough manure is supplied to the land and special care is taken to keep down weeds and insects. An indigo planter for instance desires to produce as much indigo as possible every year, and cannot therefore easily adopt a rotation on his land; but he must, if he does not do so, apply more manure, and will have to incur more trouble and expense in keeping down weeds and insects, than if a rotation were adopted. No really good plan of rotation will now be adopted by the ryot; for he objects to growing fodder crops and other restorative crops which are essential to a good plan

of rotation; but, in the practice of growing mixed crops which is so largely followed, some of the benefits of rotation are obtained. The particular rotation which may be adopted will vary according to the nature of the soil, and to the demand there is for the produce of different crops.

The following is a plan of rotation which may be recommended for dry land; but it may be varied greatly:—Let the farm be divided into four parts, and let these be denoted by the letters A, B, C and D. The crops grown in A, B, C and D, respectively in any year may be grown in D, A, B and C, respectively in the next year; in C, D, A and B in the third year; in D, A, B and C in the fourth year, and then in the fifth year the same crops will be grown in all plots respectively as in the first. This is a four-course rotation. The following is an example:—

In Field.		A.	B.	C.	D.
1st year.	Hot weather.	Gingelly (sown)	Cotton (sown last cold weather with cholum).	Cumboo (sown).	Indigo (sown last cold weather).
	Cold weather.	Cholum and cotton.	Bengal gram.	Indigo.	Ragi and dholl.
2nd year.	Hot weather. Cold weather.	As in B, first year.	As in C, first year.	As in D, first year.	As in A, first year.
3rd year.	Hot weather. Cold weather.	As in C, first year.	As in D, first year.	As in A, first year	As in B, first year.

and so on till the fifth year, when the cropping would be the same as in the first year for each plot. According to the above plan, the same crop is cultivated on the same land at intervals of four years. If an estate of 20 acres be divided into 4 equal parts, every year 5 acres' produce of each of the crops above mentioned will be obtained.

CHAPTER XIII.

The Commoner Crops and their uses.

Classification of crops.

Crops are usually classified under the headings of—Food-grains; Industrial crops; and Miscellaneous crops. The Food-grains are divided into cereals and pulses, of which the following are the more common:—

Cereals.—Paddy, cholum or jonna, cumbu or sazza, tenai or korra, varagu or arike, shamai or shama, wheat, maize or Indian corn, ragi, etc.

Pulses.—Bengal gram, green gram, black gram, red gram or pigeon pea or dhál, &c.

Industrial crops are sub-divided according to the nature of the substance they produce. The more important are:—

Oil-seeds.—Castor-seed, gingelly, ground-nut, niger or rape, &c.

Fibres.—Cotton, Sunn-hemp, Dekhani-hemp, &c.

Sugar crops.—Sugar-cane, the date and palmyra palms.

Dye crops.—Indigo, cheyroot, &c.

Tobacco is also an industrial crop.

Amongst the Miscellaneous crops may be mentioned—vegetables, such as brinjals; fruits, such as plantains and mangoes; condiments, such as chillies; spices, such as coriander seed; and many others.

Paddy.

Of the cereals, paddy is perhaps the most commonly grown: it is found in two principal sorts; namely, *samba* and *kar*. The rice of the former sort is usually white,

and that of the latter red or brown. These sorts, which are named chiefly according to the season at which the crops are raised, are sub-divided into innumerable varieties, each of which possesses different characters; thus, there is the 'Sixty-days Samba,' really a three-months crop; the 'White Kar' paddy of which the rice is white; and *Moshanam* paddy, which is a salt-feeder. Paddy is practically the sole crop raised under wet cultivation, which system of tillage has already been described, and the evils of the usual practices followed have been pointed out. As a rule, the crop is allowed to become very much over-ripe before it is harvested; it should be reaped as soon as the grain has become so hard as not to give out any milky juice when pressed between the finger and thumb. If it be kept on the ground longer much of the grain may be shed, that is drop from the ear and be lost, whilst if it be reaped as directed the straw will be much more nutritious to the stock fed with it. By early harvesting, the labor of watching the crop is also reduced. In selecting seed paddy, the grain which falls off the sheaves when they are simply shaken should be taken, and carefully preserved. Some varieties of paddy occupy the land for four, and some for as much as six months.

Nearly all the common cereals take about four months to grow, and they all like paddy should be harvested much earlier than they now are. The season for sowing them varies in different districts, and with the different varieties of each crop which are sown on different soils, or under other varying conditions.

Cholum and its varieties.

Cholum is found in two chief sorts, the white and the yellow, so named according to the color of the grain in each case; but each of these sorts has

several varieties, distinguished from each other by the character of the ear—whether it be close or open—and by the conditions for which it is suitable, *i.e.*, for growth as an early or late crop on dry land, or under occasional irrigation. There are also two other sorts of cholum, namely the red and the black; the former being usually a garden crop, and the latter being grown on the poorest soils in the southern districts and occasionally elsewhere as a fodder crop. White cholum is usually a late crop, and is grown to a wide extent on the stiffer, or *régada* soils, but varieties of it are also grown in gardens. Yellow cholum is usually an early crop in the Ceded districts, but is also sown late in others, and is more usually found on the poorer soils than the white sort. The grain of cholum is a very valuable food, and is eaten by a very large proportion of the cultivators and working classes.

Cholum as a fodder crop.

The straw is a good and generally highly prized fodder, but that of the ripe crop is coarse and hard, and if the grain has been allowed to become over-ripe, as is usually the case, much of the nourishing matter is lost and the straw becomes fibrous and inferior. The crop may, however, be cut when it first flowers and the straw is then a most excellent fodder which is especially valuable for milch cows. If after a crop has been cut in this manner, the land on which it grows be watered and hoed, a second cutting of green fodder may be obtained in about two months more from the same roots, and the process may be repeated several times and as many as four or five cuttings obtained. If a crop of cholum be well tilled, manured, and watered, and treated in the manner described above, as much as 25 tons of excellent green fodder may be raised on an acre of land from it. The other cereal

crops may also be treated in a similar manner for raising fodder, but they neither produce so much nor such good fodder as cholum.

The other cereals.

Ragi, cumbu and tenai each have different varieties for growth in ordinary dry land, and in gardens under occasional irrigation. *Ragi* is also often grown as a first crop on wet lands where the supply of water for irrigation is small, or has for part of the year to be obtained from wells. It produces a grain which is very extensively eaten by the classes who live on cholum, and is grown very largely on the dry lands of the uplands of Mysore, Salem and North Arcot, and also in other places, being then usually sown mixed with pulse crops, and in some places with cotton. Ragi straw is a fairly good fodder.

Cumbu is usually grown on the lighter soils, and is most frequently an early crop; that is, it is sown with the early rains. It is also sown in gardens either at the same season or earlier in the hot weather. It produces a food grain of considerable value, but the straw, being usually cut when the crop is very over-ripe, is usually coarse and harsh, and is generally used for thatching. It also is most commonly sown on dry land mixed with pulses and sometimes with cotton.

Tenai produces a food grain of superior quality to the two crops just mentioned, and is usually grown on dry land of fair quality, and sown with the early rains. It is often sown with cotton, but is not usually mixed with the pulses. It produces a straw of fair quality as a fodder, and the grain, besides being used as a food for man, is often given to milch buffaloes.

Shamay and *Varagu* are inferior crops almost always found growing on the poorest dry lands, the grain of which contains a comparatively large proportion of husk, whilst the straw of the latter is regarded as of the poorest quality, and is even used as a manure in parts of North Arcot.

Wheat is a very valuable crop, but it does not flourish well in most parts of the Presidency, and is usually grown under occasional irrigation.

Maize is also only grown on small areas, but is a crop which might be much more largely raised, as it produces a very valuable food-grain, as well as a very rich fodder.

The Pulses.

The pulse crops are for the most part usually grown mixed with one or other of the cereals, Bengal gram and horse gram being the only ones which are commonly grown alone over large areas. Of the others the most important is Red gram (*Tuvarai*, Tam.; *Kandi*, Tel.). From it *Dhál* is made, and the dhál made from it is of such importance that the crop is often called *Dhál*. It is always sown mixed with one or other of the cereals, and usually early in the season in lines three or six feet apart. It stands on the land about six months, the other crops amongst which it is sown being harvested about two months earlier. The stems of this plant are used in some places for making charcoal for the manufacture of gunpowder. They may also be used for thatching, or for making rough baskets.

Green gram (*Patcha Payaru*, Tam.; *Pesara*, Tel.) is largely grown on all sorts of soils and always mixed with one of the cereals. It affords a large supply of pulse and ripens soon after the cereals have been harvested. Black gram (*Ulundu*, Tam.; *Minumulu*, Tel.) is usually grown by itself on

stiffer soil than green gram, but is not raised on a large area. There are other pulse crops, such as cow gram (*Karamani*, Tam.; *Alatsandalu*, Tel.); beans (*Mochai*, Tam.; *Anumulu*, Tel.) and others, which are also grown in mixtures with the early cereals. All of these produce valuable food grain, and the straw and such of the leaves as can be preserved are highly prized as fodder, whilst the husk of the grain is a much valued cattle food.

Horse-gram.

Horse-gram (*Kollu*, Tam.; *Ulavalu*, Tel.) is the most extensively grown pulse crop which is usually sown alone. It is especially a crop for the poorest soils and the driest climates, although it is also often sown on better soils mixed with the cereals or with cotton. When sown alone, it is usually put in late in the season, as it does not require much rain for its growth. The grain produced is generally used for feeding cattle and horses, although it is sometimes also eaten by man. It is usually first boiled, but if it be steeped in water until it has swollen as much as possible and then only pounded before it is given to cattle, it is more nutritious and the preparation of it is less costly. The crop may also be grown to produce green fodder, or for green manuring, and then it may be sown at any time of the year when the soil is moist enough. The green fodder is a very useful one, and especially valuable for sheep. The dry plants obtained from the ripened crop are also a good fodder.

Bengal gram.

Bengal gram (*Kadalai*, Tam.; *Senaga*, Tel.) is so called as being the pulse or grain chiefly used in Bengal for feeding horses. It is usually grown by itself on the stiffer soils, and flourishes on *régada*. It is usually sown late in the season, and depends greatly

on the dew for moisture. It likes a deeply prepared soil, and should be sown deeply. The grain is eaten either roasted whole, or cooked in the ordinary course with other food.

Industrial crops.—The most inportant and commoner oil seed crops grown in the Presidency are castor-seed, gingelly, and ground nut; but in some places safflower, linseed, and niger or rape are also grown to a considerable extent, and in others the cocoanut palm is grown for the oil obtained from the nuts, as well as for the fibre from their covering. Oils are used for one or other of the following purposes; namely —in cookery, for lighting, for greasing machinery, for anointing the body, and for making soap, candles, &c. Many of the oil seeds produce, besides oil, a valuable oil cake, which according to the nature of the seed may be used as food for cattle or as a manure. At present the greater portion of the oil seeds produced are exported from India, and thus a large amount of fertilizing matter is lost to the soil. The crops are therefore exhaustive, and the cultivator must in consequence be careful how he grows them, as has already been explained.

The oil seeds.

Of all the oil seeds, castor-seed is the most commonly and generally grown, for besides a very large growth for export, it produces domestic lamp-oil and is largely used in greasing carts and machinery. Of it, there are two main varieties; one producing large and one small seeds. The oil obtained from the former is usually called lamp-oil, and that from the latter is used in medicine. The crop is sometimes sown in mixtures with the cereals, such as ragi, but it should properly be grown alone in lines about three to six feet apart, and the land should

Castor beans.

be thoroughly well tilled for it before and during the growth of the crop. It occupies the land for the greater part of a year, only being removed when it dies off in the dry weather, and frequent gatherings of the seed pods are made from it as long as it continues to fruit. These pods or capsules are then placed in the sun to dry, when they split open and the seeds within are easily separated. The oil is extracted from the seed either by boiling them after roasting and crushing, or by heavy pressure between plates of iron. One hundred pounds of seed will give about 35lb. of oil. The crop is generally hardy, but suffers occasionally from the attacks of caterpillars which devour the leaves.

Gingelly.

Gingelly (*Ellu*, Tam.; *Nuvulu*, Tel.) is a much more delicate crop than castor-seed. It is usually grown as an early crop, sown with the first rains of the season, but it is also sometimes sown on wet-land after the paddy has been harvested. The crop occupies the land about four months. The seed should be sown in lines about a foot apart and about a quarter of an inch deep. In harvesting, the whole crop is reaped, and the plants are generally stacked for a few days and allowed to dry; they are then spread in the sun, and the seed-pods open, and then the seed is easily separated by beating the plants on the ground. There is danger of losing a great deal of the seed by its dropping in the field, if rain falls on it when the crop is nearly ripe, for then many of the pods will burst when the rain dries up. Rain on the plants after they have been reaped is also apt to do damage, by causing the seed to sprout or become mouldy. There are two varieties of this crop, one producing red or brownish seeds and the other with white seeds. Oil is obtained

from the seed by crushing it in the ordinary mill, and if very pure oil is wanted the husk on the seed is removed by washing it repeatedly in cold water. A very large amount of gingelly seed is exported to Europe, where the oil is much valued.

Ground-nuts.

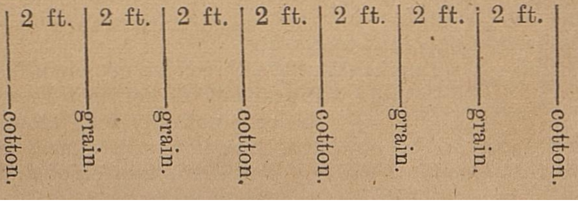
The ground-nut crop is grown most extensively in the North and South Arcot districts, but it is becoming common in many others by degrees. The crop is so named on account of its peculiar habit of growth, for after the yellow flowers have fallen off, the small seed-pod becomes pointed and buries itself in the soil and developes there. The crop flourishes on a free soil rich in lime, and during its growth the soil should be kept open by thorough inter-cultivation, so that the pods may easily bury themselves in it. The crop should be sown in lines about nine inches apart, as much as 100lb. of seed being sown to the acre. The seed should be first freed from the husk, but the inner covering of it must not be broken. The crop occupies the land for five or six months, and when it is ripe, the plants, or creepers, should be reaped and dried: they form a very good fodder. The land should then be ploughed with an improved plough, and most of the seed-pods will be brought to the surface, and can then be easily picked off by hand. A ton of pods is a heavy yield. A hundred pounds of pods will yield about 70lb. of seed. The seed may be crushed in the ordinary oil-mill, but the greater part of the seed produced is at present exported to Europe.

Fibre crops; Cotton.

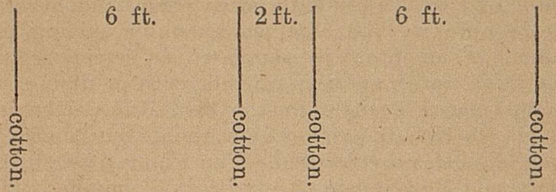
The most important of the fibre crops grown in the Presidency is cotton. From this crop not only may clothing, and oil be obtained, but it also produces a valuable food for cattle. There are two chief and

common sorts of cotton grown in the Presidency; one a small almost branchless plant generally sown on the black-cotton soils, either alone or mixed with *korra*, and sometimes with horse gram; the other a larger and much-branched plant, usually sown on the red soils and often kept standing for several years; the latter is often sown mixed with cumbu, ragi, cholum or other grain crops, either in lines or broad-cast. Broad-cast sowing is especially bad with a crop like cotton which stands for a long time on the land, and encourages the growth of weeds. The best cotton is grown on the black soils which pre-vail in the Ceded Districts, Coimbatore and Tinne-velly. A soil rich in organic matter and lime, and a climate where gentle and frequent rains alternate with bright sun-shine, is most favorable to its growth.

The American cotton, called New Orleans, is well suited for cultivation in this country, and a variety closely resembling it, called Bourbon, is at present cultivated largely in Coimbatore. With deep culti-vation and liberal manuring it produces very good results, whereas the native cotton, under such conditions, produces much wood and leaf instead of more cotton. For this crop, the land having been well ploughed, subsoiled, harrowed, manured and ridged, and the crests of the ridges having been made even, cotton and a grain crop should be sown on the ridges in alternate double rows as shown below:—



The grain crop being harvested in four months, the cotton will remain in lines alternately 2 feet and 6 feet apart, as shown below :—



The land should be kept clean by being frequently hoed and ploughed between the rows so that the soil may be thrown against the plants. The crop begins to bear in four months, and frequent gatherings are made during the next six or eight months. Soon after the bolls, that is the fruits, of cotton have burst, the cotton should be gathered ; otherwise it will be injured by dust or by holes being made in the seed by insects from which oil will exude and make the cotton dirty. Cotton should not be gathered in the morning when wet with dew. The gathering may commence at about 8 A.M. Under fair conditions, about 300lb. of seed-cotton may be obtained per acre, which on being ginned gives about 100lb. of clean fibre. Ordinary country cotton rarely yields more than 25lb. of clean fibre to 100lb. of cotton-in-seed.

Cotton seed is good food for cattle, and is given to them ground to a paste with water. In America, oil is extracted from the seed and the refuse cake used as food for acttle.

Other Fibre plants.

Sunn-Hemp, and Dekkani Hemp are one or other commonly grown for fibre, the latter being obtained from the stems of these plants. They should be sown

thickly, so that they may grow tall with few branches as explained below. They are four months' crops, and when they flower they should be pulled up by the roots, by which means longer and more fibre will be obtained than by cutting the plants. The fibre is separated by steeping the plants in water, and it is advantageous to dry Sunn-hemp plants a little in the field before steeping them, as the time for which the plants must be steeped is thereby reduced. The plants after being stripped of their leaves are tied in bundles, and placed in water to steep, being kept under water by stones and other weights. The plants will be sufficiently steeped in about three days in hot weather, the stems are then taken in the hand and bent, so as to break and separate the woody parts of them from the bark which contains the fibre. The broken stems are then beaten on the water or on a rock, and the pith and the woody parts as well as the gummy portion of the bark are washed out. The fibre is then dried and tied up in bundles. 'Dekkani hemp' generally takes rather longer to steep, and the bark can then be peeled off the stems by hand, and washed and dried as described.

These fibres, as well as that of the American Aloe, are used for making ropes, and that of the Sunn-hemp especially for making gunnies. The leaf and tender shoots of the Sunn-hemp make a good fodder, and in some places the plant is grown for that purpose. The leaf of Dekkani-hemp' has an agreeably sour taste, and is used in cookery.

Sugar-cane.

The chief sugar crop of the Presidency is the sugar-cane, a crop which occupies the land nearly a year. It is usually grown on wet-land or in gardens, and is regularly watered. It likes a rich, but toler-

ably free soil, and must be well manured and requires plenty of water. The crop is most commonly planted about the beginning of the new year (April), but the season varies in different parts of the country. As it occupies the land about a year, harvesting and planting go on at almost the same time, and usually a portion of the crop is kept over at harvest to produce seed-cane. The land for the crop should be thoroughly and deeply ploughed, and if possible subsoiled, ridged and manured and the cane cuttings may then be planted, after the land has been well watered, in the soft soil between the ridges. The cuttings may either be the top joints of the cane or portions of the stem, but each should have at least two joints in it; they may be sprinkled over with cow-dung water and kept moist under paddy straw for several days before they are planted out, when buds will shoot from each joint, and they will then take root quickly. They should be planted in rows about three feet apart, and at intervals of about a foot in the rows. During its growth the crop requires frequent waterings and hoeings, and the soil should be gradually drawn up around the plants to support them, making a ridge on which they grow where was previously the furrow in which they were planted. When the crop becomes thick, the lower leaves may be pulled off and taken away or buried in the furrows, and some of them should be wound round the stems to protect them from the jackals. There are many varieties of sugar-cane; some with large soft stems, others with thin hard ones; some very rich in sugar and others much poorer.

The crop is usually grown for the production of sugar, which is obtained from the canes by squeezing out and then boiling down the juice. In making

sugar or jaggery, the canes are cut off near the root and stripped of their leaves and then passed between the rollers of a mill. Iron mills are now becoming very common in many places, but the ordinary mill consists of a pair of smooth wooden rollers between which the canes are passed, thus squeezing out the juice, which is then carried in pots to a large open pan placed over a fire, and evaporated till jaggery is obtained. The crushed canes are first dried in the sun and then used as a fuel for boiling down the juice. The ashes obtained thereby are not often applied to the soil as a manure, owing to their being considered injurious by the ryots. The tops of the canes are often used as seedlings, but may also be used as fodder, and if the crop be cut down when about seven months old, it produces a very large quantity of excellent green fodder. The crop is usually replanted every year, and very seldom in the same land, but occasionally the old roots are allowed to produce a second crop of canes—called rattoons—but though these canes are usually richer in sugar than those of the first growth, they do not yield so much per acre as the first crop. The expense of growing a crop of rattoons is of course less, but it is seldom that land in the Presidency can bear the second crop.

Dye-crops; Indigo.

Of the dye crops mentioned, indigo is the only one which is very widely or commonly grown. This crop flourishes best on a rich alluvial or loamy soil. The land should be first thoroughly well tilled and then consolidated at the surface by being rolled, so that the seed may be sown close to the surface and not buried too deeply. The seed is a very small one, and should be sown in lines a foot apart mixed with a little ragi or *tenai*, which will come up rapidly and indicate the lines long before

the indigo plant can be clearly seen. About five pounds of seed will suffice for an acre of land. During the growth of the crop, it should be kept clear of weeds by frequent hoeings: when it begins to flower it should be cut as close to the ground as possible, the plants can then be tied into bundles, and taken to the vat for steeping and extracting the dye from the leaves. Good indigo, when a cake of it is broken, shows a rough surface with a bright coppery color in places; it should also be light in weight. The refuse indigo plants, after the dye has been extracted, make a very valuable manure, and the water which is run off from the vats should also be utilized for irrigating purposes. The crop often occupies the land for two seasons, and then very frequently a very valuable crop of seed is obtained from it in the second year, but seed is not easily produced in all places, and the crop more frequently only stands for one season during which it produces one, two or three cuttings according to the weather and whether it has been irrigated or no. Under irrigation, the crop will yield a cutting once in about three months, but it is seldom advisable to keep the crop down for three cuttings. The crop is grown on both wet and dry land, and on the former it is often raised as a second crop after, or as a first crop before paddy, and sometimes a partial second growth of it is raised and ploughed in as a green manure for that crop.

Tobacco.

Tobacco is raised from plants first grown in a nursery and then planted out in the field. For the nursery or seed bed, a narrow strip of land about three feet wide should be selected; it must be narrow so that every part of it may be easily reached for watering and for weeding. This piece should then be dug

over to a depth of about 18 inches, and the soil raised up at least six inches above the surrounding land, manured, and levelled, and the surface soil made very fine. Ashes are a good manure for tobacco. An ounce of tobacco seed will produce plants enough for an acre of ground. The seed should be scattered only on the surface of the seed-bed and simply pressed lightly into the soil. For façility of sowing a little ashes may be mixed with the seed. The surface of the seed-bed should be moistened gently but very frequently, weeded, and if the seedlings come up too thickly they should be thinned out. The proper time for sowing the seed varies in different places, but when the seedlings are about six weeks old they should be planted out in the field, which has in the meantime been prepared for them. The land selected should be thoroughly well tilled, and not too heavily manured for the tobacco crop, it being better that the previous crop should have been heavily manured. It may then be ridged and the seedlings planted on the ridges, care being taken that the roots are not curled up in planting. Planting should be carried out in the evening. During its growth the crop should be frequently hoed, and the surface soil kept perfectly free and clean, and it may be watered in the furrows as often as is necessary. A little before the flower-bud appears, the top of the plant should be nipped off leaving about a dozen leaves on, and thereafter if suckers appear where the leaves join the stem they should be removed twice a week. About two months after planting the leaves begin to show signs of maturity, that is, they become gummy to the touch and spotted with yellowish spots. The plants should then be cut off close to the ground and removed to a shed as soon as possible for drying and curing. The process of drying and curing

is a long one, and needs special care and training, and cannot be described in this little book. The outturn of dry tobacco leaf per acre for a fair crop is about 750lb. (30 Madras maunds).

The miscellaneous crops mentioned at the beginning of this chapter are for the most part grown on small areas in gardens, although a few of them are sometimes ordinary field crops, and regarding them reference must be made to larger and more advanced books on the subject.

CHAPTER XIV.

The Breeding of Farm Stock: their management in health and disease.

Farm stock defined.

Farm stock in this country are almost entirely confined to cattle and buffaloes, sheep and goats. In Europe, horses, swine and poultry also commonly form part of the stock of the farm. Cattle are especially useful to the farmer: bullocks are used for purposes of draught, that is, for ploughing, carting, drawing water from wells, &c.; whilst cows give milk, and in Salem, Coimbatore, and some other places are employed to some extent for purposes of draught.

Poor quality of the cattle.

The character of the cattle in most parts of this Presidency is unsatisfactory; for very generally the working cattle are too weak to draw a plough which makes a furrow 6 inches broad and 5 inches deep through moderately stiff soil, and the average yield of milk from a cow is only about a measure daily for a short time after calving, and goes on decreasing until in 6 months or less the cow becomes dry, whilst the milk is so poor, that is, deficient in cream, that a Madras measure of it does not produce more than about six rupees or $2\frac{1}{2}$ ounces weight of butter, &c. Under proper management, however, a cow may be expected to give about 1,000 measures of milk in the year, and about 3 ounces of butter may be obtained from a measure of good milk. Besides this, cattle do not increase as fast as is desirable; for a heifer seldom breeds until she is about 5 or 6 years old, whereas under good man-

Besides this the following points must be looked for in each animal:—The head should be broad between the eyes but tapering towards nostrils, which should be large and open; the eyes should be of medium size, prominent, not sunken, gentle, bright and lively; the neck short and thick, and in the bull with a good masculine crest; the chest wide and deep; behind the shoulders, the body should be round or barrel-shaped and the back should be nearly level from behind the hump to the set-on of the tail; the ribs should be carried well back towards the pin or hip bones, and the loins should be broad and muscular; the hips wide and the hind-quarter strong, level, and full of muscle; the legs should be short and set straight, with the hoofs hard and clean, and the toes not too widely separated one from the other.

In the cow, if the hips be narrow and the back slopes away to the tail greatly, there will be less space for the womb than when these parts are level and wide, and therefore the calf in the womb cannot grow properly, and delivery may also be difficult; the udder should be large and deep, but rather long from front to back, and should, after milk is drawn, shrink considerably (the udder may be large, not owing to its containing much milk, but to being fat and then it will not shrink much after milk is drawn); the teats should be moderately large and set well and squarely apart; the condition of the teats should be such that milk may be drawn through each of them, for the udder consists of separate milk bags each connected with a separate teat, and if milk cannot be drawn through any one teat, one-fourth of the udder is of course useless.

In all cattle, the skin should be soft and elastic, and should move freely over the ribs when handled, but at the same time it must not be too loose or too thin.

agement she may bring forth a calf when about 3 years old. The cows again do not calve regularly every year, whereas this result may be obtained under proper management. Cattle disease also is very common, and carries off very large numbers of beasts. The breeding and management of cattle in this country, therefore, is a matter of great importance.

First conditions of good breeding.

In the first place, only the best cows should be selected for breeding from, and in order that they may produce really good calves, a good bull must be chosen to serve them; for, as with plants, a seed is sure to produce another plant like the one which produced it, so with animals 'like produces like.' The selection of a good bull is especially important, as a bull may propagate many calves, but the cow only bears one at a time. But it is not enough to select a good bull; all inferior bulls should be castrated when young, say when under two years, lest they propagate their kind and thus spoil the herd. Early castration is to be recommended also because it is comparatively painless to the young animal. As a rule, bulls are not castrated by the ryots until they are from 3 or 5 years old, and as these bulls are allowed to run with the cows while on the grazing grounds, it very often happens that the latter are served by wretched half-grown beasts.

Selection of cattle for breeding.

In selecting an animal for breeding purposes, attention should first of all be paid to the character of the parent bull and cow from which it has sprung; for instance, if it is desired to breed dairy cattle, both the bull and the cows used should have been descended from good milkers.

Spirit is important in a draught animal, but a mild temper is of great importance in the cow, as irritable cows are usually bad milkers. It is also desirable that cattle should be good feeders. Some cows are of such a nature that they consume a large quantity of food and convert a great portion of it into milk, whereas others will convert the greater portion of the same kind of food into fat, and store it up in their bodies. Cows of the latter sort are only fit for the butcher. Animals which are neither too old nor too young should be selected for breeding. A properly fed heifer will be fit to be put to the bull when about two or three years old, and a properly fed bull will be fit to breed with when about $2\frac{1}{2}$ years old. A bull should rarely be used for breeding purposes for more than 3 or 4 years, and cows more than 10 years old should not generally be put to the bull.

Different systems of breeding.

There are two systems of breeding, viz., in-and-in breeding and cross-breeding. *In-and-in* breeding is the breeding between bulls and cows of close blood-relationship; for instance, if the bulls for breeding be always selected from the owner's own herd, it necessarily follows that in the course of a few generations the herd will be of close blood-relationship, the bull covering many half-sisters, and, if he be kept too long in the herd, even his own progeny. By breeding thus for some time, the bodily and physical characters of the herd will become fixed and decided, and if these be good, great benefit will result, but if the animals bred from possess any bodily infirmities or defects, these also will become fixed and more strongly developed. *Cross-breeding* is the system pursued when the owner of a herd always selects his bulls from other herds, and so any chance of the bull covering his own relations or progeny

is avoided. By this system, when careful selection is made, it is possible to correct the points in which one herd is deficient by securing a bull to work in it, which is especially good in such respects. There is also no danger of developing or concentrating the bodily infirmities of the herd from which the bull comes or of that to which the cows belong.

Breeds of cattle.

The two chief breeds of cattle in Southern India are the Nellore breed and the Mysore breed. The former are usually tall, long-legged, flat-sided animals, with a slow heavy gait, and are mild and docile in temper. Their horns are usually of moderate length and blunt, and they are very frequently of a white color. Bullocks of this breed perform a large amount of work on soft soils, such as *régada*, but are unsuited for hard and gravelly soils. The cows are often good milkers. The Mysore cattle are of moderate size, generally of a grey color, with long and pointed horns, short legs, and a round compact body. They are very active and quick in their movements, and well-fitted for carting, but are excitable and not so docile as the Nellores. Their feet are usually good, and stand work on the roads and on hard gravelly soils. The cows are not, as a rule, good milkers.

There are various other kinds of cattle in the Presidency, but the above named are the two best known, excepting perhaps the Kangiem breed bred in Coimbatore, which is found all over the southern districts, and produces many good, compact, docile, and strongly built bullocks, while the breed is also noted for dairy purposes. In breeding, it is seldom advisable to take a bull of one breed or type and to use it on cows of another.

The evils of bad feeding.

In this Presidency the cows and young cattle are for the most part most miserably fed. The sun-burnt straw of over-ripe grain crops, which, as said before, does not contain much nourishing matter, is sparingly given to them, and they are sent out to the waste and rocky lands of the villages for grazing, where but a scanty supply of poor grass is available, to pick up whatever they may find there. The food they thus obtain is for the greater part of the year hardly more than enough to support their existence, and the labor they undergo to obtain it is great, owing to the distances they have to travel to find it. The cattle suffer most for want of fodder in the hot and dry weather, whilst fodder might be supplied for them at that time, if fodder crops were grown.

The growth of fodder crops.

Most fodder crops do not, and should not, occupy the land more than about two or three months, and a crop of horse-gram especially will, as stated before, give a fair out-turn of nutritious fodder, if only sown in moist soil after it is ploughed and harrowed. Sugar-cane, maize and cholum, it has already been said, give a very heavy out-turn of fodder under proper cultivation and irrigation. No large area will, therefore, be needed for producing fodder for stock. The ryot should not consider it a vain expense to grow fodder; for properly fed stock will pay by their doing better work or giving more milk of a better quality. In some parts of the Presidency, such as parts of Coimbatore, Tinnevelly, and Cuddapah, a little cholum or cumboo is grown for the purpose of producing fodder, which is cut before it flowers, but generally this fodder is solely used for the working bullocks, and the breeding stock receive the least possible attention. In parts of the Tinnevelly District and in a small part of

Madura, cholum is grown for fodder, under the name 'Chola-nathu.' Fodder crops then are already grown and many more should be.

The growth of Guinea grass.

Besides the fodder crops already mentioned, there are two grasses which deserve some notice; viz., Guinea grass and Hariali grass. From a single plant of Guinea grass numerous side shoots with roots are produced. These may be taken and planted out, the land having first been ploughed, harrowed, manured and ridged. The planting should be done when the soil is thoroughly soaked by rain, and the weather is showery or cloudy. The shoots should be planted on the ridges two feet apart in either direction, and will in a short time strike root and grow. When the grass is well rooted, the ridges should be broken into a number of hillocks, as it were, by working a plough across them between the tufts of grass. Once in two months a crop of fodder may be cut as long as the soil remains moist. In dry weather, if no water be supplied to the crop, it will apparently become dried up and dead, but a fair shower of rain will make it green again. Guinea grass, when first eaten in large quantities by cattle not accustomed to it, causes a little purging, but if it be given in small quantities at first, and the supply be gradually increased, no ill-effects will follow. Any surplus grass may be dried and stored for use when fodder is scarce. Guinea grass may be kept on the same land for about three years, and the roots when finally taken out make excellent bedding for cattle.

The growth of Hariali grass.

Hariali grass should be planted in rainy weather as follows:—The land having been thoroughly tilled, cleaned and manured, a shallow furrow may be made by

the country plough, and in it the roots of hariali grass, which have been gathered for planting, then dropped close to each other and will be covered by the soil, which is thrown aside when the next furrow is made. When the whole land has thus been planted, it should be rolled or otherwise consolidated. Under occasional irrigation, the grass will grow very well. Care should be taken not to allow bulb grass (*korai*) and other inferior grasses to grow amongst hariali and to see that the ground is thoroughly covered by hariali grass alone. In the first few years the grass should not be grazed, but only used for producing fodder, which should be cut and removed or made into hay and stored. Later on it may be either treated in the same way or used as pasture on which cattle may be grazed. It is well as soon as the first good shower of rain has fallen to pass a country plough through the whole of the field every year, and then to roll it down again; any manure that can be spared being put on before the ploughing is performed.

The method of making hay from Hariali grass is as follows:—The grass should be cut as soon as it flowers, and then a number of coolies should turn it over frequently and toss it in the air, so that it may dry uniformly and no part of it may be unduly exposed to the sun. In the night the grass should be collected into small heaps, and next morning again spread and turned over constantly as before, being collected into larger heaps the second night. It may need to be treated thus for about three days, when it will be dry enough to store, though it may still retain a greenish color. It will then have very agreeable odour.

All the sorts of fodder should be dried in a somewhat similar manner, and should not be exposed too much to the sun, and never to rain, or they will become less nourishing.

In parts of the Coimbatore district it is customary for the ryots to sow grass (*Kaleikatei pullu*) on part of

their patta lands, to provide grazing for their stock. This practice should be followed elsewhere.

The importance of fodder.

It is on the fodder they eat that cattle chiefly depend for subsistence. In order to allow them to make the best use of what they eat, fodder should be cut into small pieces before being given to cattle. In some places cholum straw is chopped up into pieces about a foot long and then given, but it is better to cut it much smaller. By a machine, called the chaff-cutter, such fodder may be cut almost as small as we please. If long straw be given to cattle, much of it is wasted. When possible, it is well to give the cattle a mixture of dry and green fodders, and to milch cows a larger proportion of the latter should be given than to working cattle.

The use of artificial foods.

It is a very common practice to give soaked cotton seed or horse gram to working cattle, but the use of such or of similar foods for cows, &c., is not as yet common, although she-buffaloes are often allowed some cotton seed during the time that they are giving milk; but it would be well to give all sorts of stock some such food in addition to their fodder, when possible. Besides the substances already mentioned, most of the oil-cakes make very nourishing foods for cattle. Of these ground-nut cake is the most nutritious, gingelly cake comes next, but cocoanut cake is comparatively poor. Oil-cakes should be broken in small pieces, and steeped in water for about 12 hours before being given. To full grown cattle 3 or 4 lb. of cake may be given per day and to a sheep $\frac{1}{2}$ lb.

The value and use of salt.

Common salt is as necessary an article of food for cattle as for man, and should be given daily to stock. Cattle

and other animals frequent salt land and lick up the salt earth when they do not obtain enough salt otherwise. The salt helps to digest food well; and generally aids in maintaining the animal in health, and as a preventive of disease. It also kills the worms in the bowels. Two or three ounces of salt may be given to full grown cattle daily, and about $\frac{1}{2}$ ounce to a sheep.

The supply of water.

Water should be freely supplied to the cattle to drink; if at pasture, they should have free access to a good supply. Too frequently cattle are watered at any dirty stagnant pool near which they may be pastured. This is bad, and often leads to the outbreak of disease in a herd.

The value of shelter and cleanliness.

Shelter is another thing that must be provided by the farmer who desires to keep his cattle in good health. If cattle are exposed to the weather they require more food to keep them alive; they are very liable to sickness; and are often destroyed in large numbers during times when there is excessive rain. The shelter provided should be sufficient to keep off the sun and the rain, and to keep out cold winds, but at the same time must be sufficiently open to allow the animals plenty of fresh air. Besides this the floors on which the cattle stand must be kept clean and dry, well drained and well littered. Cleanliness in the management of cattle will always be repaid, as it tends to keep the animals free from disease and from such pests as ticks. Cattle should therefore be washed frequently.

The value of kindness.

Thus in the general management of cattle, the most important things to be remembered are food, water, and shelter. Besides these matters kindness is of

the greatest importance, and no man who values his beast will ever be cruel to it. It is cruel to starve cattle, to deprive them of good water, of salt, or of shelter, and unjustifiable also, when by a little trouble these can be given, just as it is cruel to burn and score their skins in all directions for the removal of some fancied evil. There are other points in the management of breeding cattle which may be alluded to, but what has been said so far, relates to their general management.

Management of a breeding herd.

In a herd, a bull should be provided for every 50 or 60 cows, and it is better that he should not be allowed to run with them, but that the cows should be brought to him to be covered when they come in season. Cows come in season about once in three weeks; that is, the cow desires the bull, and is in a fit state to be covered; but she remains in season only for about three days, and unless she is served by the bull within that time, she will not become pregnant. The signs of a cow coming-in-season are great excitement and frequent bellowing, constant flicking of the tail, and passing small quantities of dung and urine, and some thick whitish liquid with the latter; the cow will also try to ride on other cows. These signs should be watched for, and the cow put to the bull at the earliest opportunity after their appearance. A cow usually comes in season about a month and a half after calving, and should be covered then. If a cow be served by a bull while in season, it is almost sure that she will calve in 270 to 280 days from the date of service. A cow which is very fat often proves barren. Such cows should be worked in a cart or given some other good exercise, and their supply of food should be stinted. Green fodder and salt will also sometimes remove barrenness. A breeding bull

should also always be kept in exercise, and not allowed to become fat and gross.

The management of the calving cow.

When a cow is in-calf (*i.e.*, pregnant) she should be well fed, in order that she may produce a good and well-grown calf. She at that time requires food for her own support, and for the nutrition of the calf in her womb. But at the same time over-feeding is bad, as it may easily produce sickness or abortion. The common reasons which cause a cow to slip her calf before the full time has come are:—

(1) Sudden changes from heat to cold and exposure.
(2) Feeding on rank or mouldy fodder.
(3) Injuries caused by accident, or cruelty of any sort, such as beating.
(4) Over-driving, whether too far or too fast.
(5) Excitement caused by other cattle.
(6) Being kept with another cow which has slipped her calf.

A few days before a cow is expected to calve, she should be removed from the herd and kept quietly by herself in a separate shed, and fed on soft and laxative food. If a cow-in-calf be milking, she should be dried at least two months before she is expected to calve, but in this country it is seldom that cows continue to give milk for so long. At the time of calving, the cow should be left alone, and unnecessary interference with her avoided. Nature in almost all cases does all that is necessary.

Management of the young calf.

The cow should be allowed to lick the calf all over soon after it is born so as to remove the slime covering it, and after a short time the calf should be helped to stand up and suck its mother's milk. The milk which a cow gives for the

first few days after calving is of a peculiar character, for it acts as a gentle purgative, and so is useful in clearing the bowels of the calf, which is necessary soon after it is born. If the cow dies in bringing forth its calf, which is rare, a little castor oil may be given to the calf instead. For at least a fortnight after it is born, the calf should be fed once in four hours, being either allowed to suck its dam or fed by hand*. When milk commands a high sale price, the calf may be very well brought up on mixtures of such foods as oil-cake dissolved in water, and skim-milk, without suffering in consequence. When the calf is a month old, it will suffice if it be fed three times a day, and later on, besides as much food of the sort described above, what milk it can obtain from its dam in stripping the udder after milking will be enough for it until it is able to pick up its food for itself. But whatever is done, care must be taken to feed the young calf well during the first year of its life, or its frame will suffer, and it will never grow to be as fine an animal as if it had been properly cared for when young. Young calves, and especially buffalo calves, need careful shelter from exposure, but after they have reached the age of six months do not need more care generally than has been shown to be necessary for the general management of cattle.

*It is the general practice in India to allow the calf to suck its dam; but it is far better to take away the calf from its mother very soon after calving, and to rear it by hand, not allowing it to suck at all. If this be done with the first calf a cow drops, she can easily be trained to give down her milk in the absence of her calf. The saying that—"Unless the calf sucks, the cow will not let down her milk" (*Dúda kúdistégáni ávu cheepadu*)—is not based on experience of cows trained to milk properly.

Milking cows.

Dairying is the management of cows with a view to the production of milk and the management of milk previous to sale. A cow should ordinarily be milked twice a day at fixed hours, so that the udder may not become over-loaded with milk. A good milkman will not leave a drop of milk in the udder of a cow, but as usually milk-men in this country are not able to do this, it is well to allow the calf to strip the udder dry after the cow has been milked by hand. If any milk is left in the udder of the cow after each milking, the supply will quickly decrease, and after it has once lessened will not increase again. The udder may become sore if the milk be allowed to accumulate in it for long. It is a common practice to leave cows unmilked for a day or two about the *Pongal* festival, and cases of sore udder and sore teats are not uncommon among good milkers in consequence.

Management of milk in the dairy.

Milk when drawn from a cow must always be received in a perfectly clean vessel, or it will be quickly spoiled, and it must be kept in perfectly pure vessels. It is also very liable to take up bad odours and impurities, as for instance, if it be kept in a room where there are onions, it will acquire the taste of onions. It is no wonder, then, that milk should, so commonly, have a disagreeable smoky flavour, as it is generally heated in open chatties over smoking bratties. It is therefore necessary to keep the milk away from smells and smoke. It is also liable to turn sour very quickly, and does this much faster in hot than in cold weather. To avoid, as far as possible, the danger of this occurring, milk should be kept in deep vessels and placed in a cool room, which is well ventilated. The vessels in

which it is kept should be either of porcelain, glass or tin, as these are the most easily cleaned, and this should be done every day with boiling water. After being washed in this way the vessels may be exposed in the sun, but, if they are not properly cleansed, or if a particle of dirt or stale sour milk remains in them, when fresh milk is placed in them, it quickly turns sour and is spoilt.

Butter-making.

When milk is kept standing in a vessel for some time, small particles of fat rise to the surface and form a kind of yellowish scum there. This is the cream. By churning it, butter may be obtained. After the butter has been formed, great care should be taken in washing it thoroughly with perfectly pure water to remove the butter-milk. In every process scrupulous cleanliness is necessary. No dairy can be successful where cleanliness does not receive the first attention, and the absence of it is a source of great danger to the health of the people who depend on the dairyman for their milk.

The uses & breeding of sheep.

Sheep are kept by the ryot chiefly to manure his fields by their droppings; but are useful also as supplying wool from the fleece and mutton in the carcass after they have been killed. In breeding sheep, the same principles must be followed as in breeding cattle. The best ewes alone should be kept and a good ram should be selected for breeding with. All old and inferior ewes and ram lambs should be picked out; the latter should not be allowed to breed, but be castrated before they are six months old and fattened as soon as possible for sale to the butcher. The ram should not be kept with the ewe flock at all times of the year as is commonly done, for, if he is,

lambs will be dropped at all times and many will die. The ram should be kept at home and only placed in the flock to serve the ewes for a month or so at the best time of the year by which means the lambs will all be born at about the same time and can then be carefully attended to. No shelter is usually provided for sheep flocks although it would often be profitable to do so, as the number of sheep killed by exposure is very great. Besides this the lambs that are born during unfavorable weather, cold damp weather being especially unfavorable, die in large numbers. Under good management a ewe should not be allowed to breed until she is 18 months old and may continue to breed until she is about 6 years old, one lamb being usually born yearly. The ewe carries her lamb for about five months. This should be remembered in putting the ram with the ewe flock, so that the lambs may be dropped in a favorable season ; this being generally soon after the heavy rains are over, and whilst there is an abundance of green grass to produce a free flow of milk to the ewes. One good ram will suffice for about 50 ewes, but it is better to allow two for 80, placing them with the flock in alternate weeks. If the breast of the ram be smeared with a mixture of red ochre and oil, he will leave a red mark on the rumps of the ewes which he has covered. These ewes may then be removed to a separate flock, and the owner will be able to tell when he may expect his lambs to appear.

Breeds of sheep.

The sheep of this Presidency are of two classes, the hairy and the woolly. The best of the latter are the Mysore and Coimbatore breeds, but the common *Kurumb-ádu* also produces wool, whilst the *Semmari-ádu* is hairy and produces only mutton. Hair is straight and often harsh to the touch; wool is softer,

much curled, and elastic, whilst it also, unlike hair, if it is wetted and pressed together, felts, that is sticks together in one mass. Wool may be woven into cumblies, blankets, rugs, and carpets, but hair is of little or no value. Woolly sheep should be shorn before the very hot weather begins, and about 2 days before being shorn they should be well washed in clean water, such as that of a river.

Food for sheep.

Sheep chiefly depend for their subsistence on grazing, but if it is desired to make them grow well, to produce good wool, to make good manure, or to fatten them rapidly, it pays to give them a small quantity of such food as ground-nut cake and a little salt daily. Whilst it is alsoa profitable method of manuring a field to grow a crop, such as horse-gram, on it, and to fold the flock on the field until they have eaten it off. Sheep do not require so much water as cattle, but they should have free access to a good supply of it. When sheep are folded on a field it is best to confine them, as is done in some parts of the Presidency, within close limits in a pen made of hurdles, and to move the pen daily to a new spot until the whole field has been manured. It is only by folding sheep on the land that the full value of their manure can be obtained, and though the value of this manure is well known throughout the country, it would be greatly increased if the sheep were better fed than as at present when they depend for food entirely on the scanty herbage of the waste and rocky land of the village. Much of their manure is also lost owing to the necessity for driving them away to distant hills to graze during a long portion of the year.

Goats must not be confounded with sheep, although they are kept for similar purposes. They are further

valued for the milk they produce and their prolific character.

Diseases of farm stock.

Diseases often break out amongst the live stock of the ryot, but in too many cases this is due to the absence of simple precautions to guard against such attacks. Stock that are kept in clean, well paved, properly littered, and well ventilated sheds, and which are well fed and cared for, do not so often contract disease as those which are not so kept. The common signs of illness in an animal are:—

Ceasing to chew the cud and to eat; a dull heavy appearance; disinclination to move and lying down apart from other animals; the hair standing erect, or a staring coat as it is called; great heat or coldness about the horns, ears and other extremities; slobbering from the mouth; inflamed eyes from which matter runs; hard and hurried breathing and general uneasiness. Besides these signs, in many cases peculiar liquid or hard dung may be passed, or urine of unusual color may staled.

Prevention of disease.

Prevention of disease is more effective than any attempts at cure can be. Much may be prevented by careful management in the ways shown already, and the first signs of sickness or disease may be detected in time by careful inspection of the herd daily and frequently. The avoidance of common causes of disease is also necessary: amongst these are want of sufficient, or too sudden changes of food; exposure to rain and cold; and allowing stock to graze on the rank grass which grows so freely along water courses, and especially in low-lying spots immediately after heavy rains. The last cause often produces excessive purging or diarrhœa, and is due too fre-

quently to the stock being half starved during the dry weather and then to their eating too greedily of the rank grass which first springs up when rain falls.

The segregation of sick animals.

Should any signs of sickness or disease be shown by an animal it should at once be entirely separated from the others, and kept by itself in a comfortable place. The disease may or may not be one which spreads from one animal to another, but the danger from such diseases is so great, and the only effectual means of checking them being the complete separation of the sick from the healthy animals, that isolation is always advisable. The diseases which spread from one animal to another cause the greatest losses, and though they may not immediately appear in an animal that has been in contact with one that is diseased, still it may have contracted disease which will appear later on. It is therefore always desirable to keep the herd separate and distinct from others and so avoid unnecessary risk. The farmer should therefore seek to live on his own lands, and not allow his stock to leave it, or that of others to come to it, and when he purchases new stock he should not, when he brings it home, allow it to mix with his other animals for about three weeks after he has purchased it, for the disease may be in the animals but may not show outward signs for some time. Before being mixed with the herd purchased animals should be thoroughly well washed.

The more commonly fatal or injurious diseases * which attack farm animals are:—

Rinderpest—or Cattle Plague. A week to a fort-

* The notes regarding cattle disease are for the most part taken from a manual of cattle disease prepared by Mr. J. Mills, V.S., A.V.D., under the orders of the Government of Madras.

night after an animal has been exposed to infection, it falls sick and the disorder rapidly spreads in a herd. It is difficult in the earliest stages to decide as to the exact nature of the disease, but later very marked symptoms set in, of these—extreme weakness amounting to prostration; remarkable twitchings of the muscles of the body; severe diarrhœa with very foul and peculiar smelling matter, which is often mixed with blood, passed; eruptions of the membrane of the nose, mouth, and certain parts of the skin, such as those covering the female organs and the udder and a very strange cough are generally present. Cattle suffer from this disorder and sheep can take it from them. It is very communicable. It must not be confounded with simple dysentery, in which there is no eruption in the mouth, etc., nor with diarrhœa. It is the commonest and most destructive disease in S. India.

Anthrax or "*Black Disease*" is the most serious disease of all, because it can be communicated to any animal even to man; it is very fatal to cattle, sheep, and horses in India. It is seldom curable, and appears under the most varied forms. The following are the principal:—

(*a*) *Splenic Apoplexy.*—A bullock suddenly becomes ill and quite prostrate, his nose and eyelids assume a dark-red or almost black color, he passes much dark blood from the bowels mixed with dung, and dies in a very short time. When he is opened the blood is found to be black-red in color, the spleen enormous in size and full of dark tarry blood, and the body decomposes very rapidly.

(*b*) *Quarter-ill*—Commences with lameness, generally of one hind limb which rapidly becomes swollen, and gas collects under the skin which crackles when pressed upon. This form is most frequent in calves when they are first turned out on a rich pasture. As in all the other forms, fever runs high and death rapidly ensues.

(*c*) *Malignant-Sore-Throat*—Is denoted by the animal being very unwell and weak, there are all the symptoms of of inflammation of the tongue and throat, the mouth is black and the breath most offensive. Death very rapidly ensues and treatment is powerless to avert it.

(*d*) *Braxy*—Is the name given to anthrax when it affects the sheep. It is common cause of loss and may resemble either of the forms above described as seen in cattle.

(*e*) *Anthrax Fever*—Is the name given to this disease when it affects the horse. It proves very fatal and is common.

(*f*) *Carbuncles and Anthrax Fever*—Are seen in man as a result of inoculation with blood, or other matter, from diseased animals; even dry hides may convey this terrible and fatal disorder, and many people who sort wool die, from that wool having been taken from sheep which have died from braxy.

It is important to understand what is the real cause of this disease. It is due to very small parasites in the blood, which grow and increase rapidly there. When an animal dies from anthrax and his blood is shed over grass, or his carcase allowed to be torn in pieces by wild beasts and birds, these parasites fall on the soil and develope there; and may even after a year's time give disease to amimals pasturing on the grass which grows on the spot. Thus the carcases of animals affected with communicable disease should be destroyed completely. Jackals, kites, and other scavengers spread anthrax, but strange to say flesh-eating animals scarcely suffer from it. Even such apparently simple creatures as ants, flies, and earthworms are large enough to carry anthrax parasites, and spread the disease broad-cast. On opening an animal which has died of this disease, the blood is always black, and liquid like tar, those parts which are particularly diseased are very black and swollen, and decompose readily, and there are blood spots and patches in almost every part of the body.

Foot-and-Mouth-Disease—Is a highly infectious and contagious disease, communicable to animals of all kinds; even elephants and man suffer from it, and it proves very fatal to common poultry. As its name shows, it is characterised by an eruption in the mouth and on the feet, but in some cases the mouth, and in

others the feet only, are affected; but, if a number of animals are attacked, some are sure to show the disease both on the feet and about the mouth. The eruptions in the mouth are white bladders, which may be broken and then a red skin is left; they are found on the tongue, roof of the mouth, gums, &c. The feet become swollen, the animal lame, and ulcers soon appear around the coronet, and particularly in the cleft between the toes; the animal shakes its feet frequently, and saliva dribbles from his mouth ; he is too lame to roam far for his food, and his mouth too sore for him to eat freely, and so is apt to lose condition very rapidly, and needs much strengthening diet. The milk supply is diminished by the disease, and what milk is given may cause severe diarrhœa in children. The disease is seldom fatal if the animals affected are carefully nursed.

Sheep-pox—Is a disorder very like small-pox in man; it is frequent in India, and may be distinguished by pock-like eruptions inside the thighs, on the lips, and in the mouth and nostrils, in fact wherever the skin is thin, and especially on the membranes of the body. There is a discharge from the nostrils, diarrhœa, great weakness and fever. The eruptions may be few and wide apart from one another, or may run together and form large sores. The fever sets in about ten days after sheep have been in contact with diseased ones, the attack lasts on an average over a fortnight, and death may ensue from weakness. Sheep-pox is highly infectious among sheep, but it is not the same disease as small-pox or cow-pox.

Treatment of sick animals.

Immediately an animal is attacked by any of the diseases mentioned, it should be, as said before, separated from the healthy animals, and the place where it has been kept thoroughly cleansed, scraped,

and then, if it be a closed building, it is a very good thing to burn some sulphur in it, for the fumes of sulphur destroy the seed or germs of disease. The dung, litter, and waste fodder from diseased animals should be burnt, and the floor on which they stand freely sprinkled with quicklime. Sick animals should be most carefully nursed and their every want attended to. Their strength must be maintained, and for this purpose it is well to give them strong food in small quantities in the form of congee. Salt also should be given to them freely.

Dealing with diseased carcasses, etc.

One of the diseases mentioned above may be communicated to human beings with very fatal results; namely anthrax, and persons with sores or wounds on their hands should avoid handling the animals attacked with, or the carcases of animals which have died of this disease. The chucklers often cause the spread of infectious diseases by removing the hides from the cattle which have died of such diseases and selling them, as the hides carry the germs of the disease to cattle which come in contact with them. Therefore when an infected animal dies, the hide should be hacked into pieces before the animal is buried, so that the chucklers may not dig up the carcase and steal the hide. It is safer to burn the carcase of an infected animal; but, if the ryot cannot afford the expense of burning it, he should bury the carcase deeply, mixed with plenty of quicklime. If an animal suffering from an infectious disease recovers, it should not be re-admitted among the other animals of the herd for about a fortnight after recovery, and even then the animal should be thoroughly washed, and fumigated with sulphur in a closed room, before it is again allowed to mix with the healthy stock.

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